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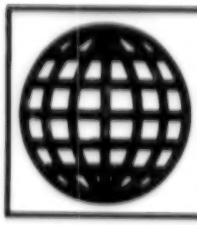

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Shock Wave Attenuation in Duct With Permeable Walls

927J0103A Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 26 No 6, Nov-Dec 91 pp 101-106

[Article by S.M. Frolov, B.Ye. Gelfand, Moscow; UDC 534.222.2]

[Abstract] An efficient approximate method of analyzing the shock wave attenuation suggested by the authors (*Fizika goreniya i vzryva* Vol. 26 No. 3, 1990) is extended to the problem of the planar shock wave (UV) attenuation in a duct with permeable walls. In pursuing their goal, the authors are primarily relying on the findings by M. Honda, K. Takayama *et al.*. The evolution of a planar shock wave with a stepped profile after entering a rectilinear duct with a constant cross section and perforated walls is considered and an approximate method of analyzing the shock wave attenuation is derived on the assumption that the shock wave velocity depends on the wall permeability, the duct's hydraulic flow diameter, the initial shock wave velocity, and the distance made good by the wave. The analytical dependence of the rate coefficient on the shock wave Mach number and its approximation are plotted and the design ultrasonic wave attenuation in the duct with permeable walls is compared to experimental data. It is demonstrated that shock wave damping with the help of mechanical obstacles and curtains is much more efficient than the use of outlets yet the presence of obstacles in ducts in undesirable due to the resulting increase in drag and the probability that combustion, if it appears, may turn to detonation. Figures 2; tables 1; references 10: 3 Russian, 7 Western.

Detonation Wave Structure in Vacuum With Unitary Fuel Particles

927J0103B Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 26 No 6, Nov-Dec 91 pp 109-115

[Article by S.A. Zhdan, Novosibirsk; UDC 534.222.2]

[Abstract] The structure of detonation waves (DV) in unitary fuel suspensions in gas which corresponds to the Zeldovich-Neumann-Doering (ZND) model is discussed and the characteristics of the structure of stationary detonation waves of unitary fuel suspensions in a vacuum are investigated. The study shows that the detonation wave in a vacuum does not correspond to the Zeldovich-Neumann-Doering model since there is no frozen shock wave (UV) in the detonation complex while the detonation wave's leading edge is a contact discontinuity. In the relaxation zone, the two-phase flow parameters are single-variable functions of the particle temperature; there is a contact gas discontinuity in the ignition plane. Constraints imposed on the domain of compression relaxation wave are calculated and the parameter profiles in the stationary detonation wave reaction zone are analyzed. It is demonstrated that in a vacuum with suspended unitary fuel particles, the detonation wave has a totally blurred structure in the Chapman-Jouguet mode. Figures 3; references 8.

Magnesium Particle Ignition Near Shock Tube End

927J0103C Novosibirsk FIZIKA GORENIYA I VZRYVA in Russian Vol 26 No 6, Nov-Dec 91 pp 139-142

[Article by Ye.V. Petukhova, A.V. Fedorov, Novosibirsk; UDC 532.529.5+541.126]

[Abstract] Ignition of small metal particles under dynamic conditions behind planar transmitted and reflected shock waves and the effect of the ignition delay on the Mach number in such systems are discussed and the phenomenon of magnesium particle ignition near the end of the shock tube, probably due to the oxide cracking prior to melting, is investigated. To this end, a mathematical model which takes into account the particle dynamics is developed. A suspension of Mg particles in a gas filling a half-space bounded by a rigid wall is considered in the conditions of transmitted and reflected shock waves and ignition of the system is analyzed with the help of the above mathematical model. A comparison to the experimental results shows that in addition to the particle motion, it is necessary to take into account the dependence of the thermal parameters of the system on its state in order to determine the dependence of the ignition delay time on the temperature behind the shock wave front. The results also demonstrate that Mg particle ignition near the shock tube end can be adequately described in the framework of the model which takes into account the low-temperature metal oxidation and the dependence of the thermal parameters on the state of the system. The consistency of experimental and theoretical data is increased by taking into account the dependence of the thermal constants on temperature and pressure. Figures 1; tables 2; references 8: 6 Russian, 2 Western.

Acoustic Signal Recording From Muon Beam in U-70 Neutrino Channel

927J0118A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 100 No 4(10), Oct 91 pp 1121-1128

[Article by A.B. Borisov, A.V. Vasilkov, A.Ye. Volotskiy, A.V. Yermolenko, B.D. Zaytsev, V.I. Kochetkov, A.I. Mukhin, V.I. Nayanov, A.D. Panferov, Yu.M. Sviridov, High Energy Physics Institute, Saratov State University, and Saratov Branch of the Radio Engineering and Electronics Institute at the USSR Academy of Sciences]

[Abstract] The possibility of recording charged particles on the basis of the acoustic signals they generate in the substance and the hypothesis of thermoacoustic generation mechanism according to which the generation of

sound is attributed to the thermal expansion of the track energy release area of an individual particle or beam are discussed and the recording of acoustic signals from a muon flux developed during the generation of a neutrino beam in the steel muon filter of the U-70 accelerator neutrino channel is examined; the reasons for so doing are stated. The dependence of the muon flux in a 140 cm dia. circle on the muon filter depth, the dependence of the muon flux density on radius in the first cross section, the time structure and frequency spectrum of the acoustic signal without reflections and in the transducer, and oscillograms of acoustic signals are plotted. The results attest to the principal possibility of using the acoustic signal for diagnostic purposes in experiments with muon and neutrino beams. The recorded signal characteristics are consistent with the thermoacoustic generation theory; the need for further studies aimed at solving the problem of dynamic applicability range of this method, suppressing noise effects, etc., is emphasized. Figures 6; references 10: 7 Russian, 3 Western.

Soliton Coupling Via Phonons in φ^4-φ^2 Model

927J0118B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 100 No 4(10), Oct 91 pp 1262-1271

[Article by O.P. Kolbyshova, A.F. Sadreyev, Physics Institute imeni L.V. Kirenskiy at the Siberian Department of the USSR Academy of Sciences]

[Abstract] The soliton-soliton coupling due to thermally excited phonons is renormalized, i.e., the potential of indirect soliton coupling via harmonic excitation is determined in a unidimensional φ^4-φ^2 model; the planar domain wall interaction in a *d*-dimensional model is considered. It is shown that after a phonon passes through two solitons, the phase shift becomes a function of distance between the solitons. It is demonstrated analytically and numerically that indirect coupling is repulsive, increases with temperature, and operates at a considerably longer range than the static soliton coupling. The pinning of soliton necessary for resolving the problem of the ground state instability of two solitons manifested in the negative eigenvalue of the translational mode is considered. The results of a numerical analysis are discussed. The authors are grateful to G.P. Berman, V.V. Valkov, and V.I. Ignatchenko for critical remarks and constructive discussions as well as V.V. Beloshapkin for providing a program for numerical solution of Schroedinger's equation. Figures 3; tables 1; references 9: 5 Russian, 4 Western.

Investigation of Samarium's Magnetic Properties by Muon Method

927J0118C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 100 No 4(10), Oct 91 pp 1353-1357

[Article by I.I. Gurevich, I.G. Ivanter, B.F. Kirillov, B.A. Nikolskiy, A.V. Pirogov, A.N. Ponomarev, V.A. Suyetin, V.G. Grebinnik, V.N. Duginov, V.A. Zhukov, A.B. Lazarev, V.G. Olshevskiy, V.Yu. Pomyakushin, S.N. Shilov, Atomic Energy Institute imeni I.V. Kurchatov and Joint Institute for Nuclear Research, Dubna]

[Abstract] The advantages of the muon method over the method of neutron diffraction for examining the magnetic properties of samarium and measuring its magnetization are discussed and the muon site magnetic field is measured in a samarium sample assembled from six 5 mm thick discs with a 30 mm diameter in the ferromagnetic state within a 16-105K temperature range. The Fourier spectrum of the muon spin relaxation and precession under the effect of internal magnetic fields and the experimental dependence of the magnetic field strength on temperature on the muon site in samarium are plotted, the crystal and magnetic structure of samarium is reconstructed, and the temperature dependence of magnetic susceptibility related to the antiferromagnetic ordering is derived; the corresponding paramagnetic temperature is calculated by the maximum likelihood method and is found to be equal to -6.7+/-1.5K. The negative value corresponds to an antiferromagnetic phase transition at 14K. It is shown that the muon is localized in two magnetically nonequivalent octahedral interstitial sites where the muon precesses. The local magnetic field of polarized conductivity electrons on the muon site is measured. The authors are grateful to N.Ye. Zeyn, M.I. Katsnelson, and A.V. Trefilov for constructive discussions and to A.F. Burtsev for assistance. Figures 3; tables 1; references 3: 1 Russian, 2 Western.

Abnormal Acoustic Wave Absorption by Two-Dimensional Adsorbed Layer on Solid Surface

927J0138A Sankt-Peterburg FIZIKA TVERDOGO TELA in Russian Vol 33 No 9, Sep 91 pp 2598-2600

[Article by Yu.A. Kosevich, All-Union Scientific Research Center for the Study of Surface and Vacuum Properties, Moscow]

[Abstract] Acoustic wave absorption by a two-dimensional adsorbed layer on the surface of a solid is discussed and an attempt to demonstrate that the two-dimensional adsorbed layer of a poorly absorbing substance with low density and sound velocity whose thickness is much smaller than the incident wave length in the solid may lead to a virtually total resonant nonreflection and surface absorption of the incident acoustic wave. Such abnormally high absorption of incident waves by a layer with a low rigidity predicted by the theory is due to an increase in the amplitude of resonant oscillations of this layer's particles. This phenomenon may be used for acoustic measurements of the internal dissipation parameters and their temperature dependence in polymer or liquid crystal Langmuir-Blodgett films which can be easily applied to a solid surface and are convenient for taking structural and dynamic measurements. It is noted that the anomalous or total surface absorption

phenomenon may also occur with electromagnetic waves incident upon the interface with an insulator or semiconductor with a dielectric permittivity of less than unity with a two-dimensional conducting layer on the surface. The author is grateful to S.N. Ivanov, A.G. Kozorezov, and V.V. Medved for constructive discussions. References 6: 3 Russian, 3 Western.

Nonlinear Sawtooth Wave in Underwater Sound Fixing and Ranging Channel

927J0153A Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 37 No 5, Sep-Oct 91 pp 984-988

[Article by O.V. Rudenko, A.K. Sukhorukova, Moscow State University imeni M.V. Lomonosov; UDC 534.222]

[Abstract] Propagation of intense acoustic waves in nonuniform media and the effect of nonlinearity on the initial signal spectrum, making it difficult to use geometrical acoustics approximation for describing quasimonochromatic waves, are discussed and it is shown that in the case of a sawtooth wave profile, it is possible to take nonlinearity into account completely. The resulting transport equation with a square law nonlinear term is derived. The process of highly distorted sawtooth wave propagation in a laminar medium whose characteristics simulate the sound fixing and ranging (sofar) channel in the deep ocean is examined in the nonlinear geometrical optics approximation assuming that a planar beam is propagating in an inhomogeneous medium with a parabolic refractive index profile and a constant density. The beam profiles at various distances from the source, the maximum pressures on the beam axis, and the equal pressure levels in the medium are plotted allowing for nonlinear focusing and isotropization. It is stressed that the approach and outcome of the study may also be used for solving at least two application problems: analyzing a parametric array radiating close to an underwater sofar channel (PZK) in the saturation mode and analyzing the propagation of explosion pulse signals through an inhomogeneous medium. Figures 3; references 5.

Recording of Small Diffuse Scattering Body Vibrations by Adaptive GaAs:Cr Photodetectors

927J0153B Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 37 No 5, Sep-Oct 91 pp 998-1003

[Article by I.A. Sokolov, S.I. Stepanov, G.S. Trofimov, Engineering Physics Institute imeni A.F. Ioffe at the USSR Academy of Sciences; UDC 535.317.1]

[Abstract] The problem of recording acoustic vibrations of real objects with a low amplitude of ≤ 0.1 μm and the shortcomings of homodyne laser vibrometers are discussed and it is shown that adaptive photodetectors are the most suitable for this purpose. The transient photo-emf (EDS) in the GaAs:Cr semiconductor layer exposed to an interference pattern formed by a reference light beam and the signal speckle field produced by reflection of real bodies from rough surfaces is experimentally investigated in order to demonstrate the possibilities of recording 10^{-1}-10^{-4} μm vibrations of a piezoelectric crystal wafer by a homodyne laser vibrometer on the basis of an adaptive GaAs:Cr photodetector. A block diagram of the experimental unit is cited and the experimental dependence of the transient photo-emf on the modulation amplitude, the dependence of the transient photo-emf amplitude and normalized emf amplitude on the lens aperture, and the dependence of the emf amplitude on the interference pattern contrast are plotted; oscillograms of the output electric signals of a phase-modulated beam are presented. The frequency dependence of the vibration amplitude of the test piezoelectric crystal surface at various distance from the wafer center is examined. The vibrometer is capable of automatically finding the operating point and equalizing the complex wave front shape and slow beam phase drift. The photodetector is relatively insensitive to the laser's amplitude noise; the minimum detectable vibration amplitude is approximately 0.0001 μm within the entire frequency band. The authors are grateful to O.L. Skobelev and D.V.Sachkov for technical assistance in making the unit and to V.V. Kulikov for constructive discussions. Figures 6; references 6: 5 Russian, 1 Western.

New Method of Describing Resonant Diffraction Due to Waveguide Mode Excitation

927J0155A Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 24, Dec 91 pp 16-20

[Article by A.A. Kovalev, P.S. Kondratenko, All-Union Scientific Research Institute of Physical Optics Measurements; UDC 01; 07]

[Abstract] The use of light diffraction on a dielectric layer with a periodically corrugated surface in laser technology and integrated optics and the difficulties arising in the case where diffraction is accompanied by resonant excitation of waveguide modes is discussed and a new method which makes it possible to obtain an approximate analytical expressions for the amplitude of diffracted waves under waveguide mode excitation in a random diffraction order for diffraction gratings with a ridge amplitude $<<\lambda$ and $<<d$ where λ is the wavelength and d is the surface corrugation period is proposed. Incidence of a planar monochromatic wave onto a corrugated surface is considered and it is demonstrated that in the case of bounded laser beams of finite duration, excitation of resonant waveguide modes (RVM) leads to a distortion of the spatial and temporal characteristics of the reflected and transmitted signals which are broadened both in the domains of space and time. The quantitative theory of this phenomenon will be discussed separately. The authors are grateful to B.N. Levinskiy for constructive discussions. Figures 1; references 5: 4 Russian, 1 Western.

Single-Wavelength (AlGa)As Quantum Dimensional Lasers With Low Lasing Action Threshold

927J0155B Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 24, Dec 91 pp 99-102

[Article by K.B. Dedushenko, O.V. Katugin, A.Z. Mereutza, A.V. Syrbu, V.P. Yakovlev, Kishinev Polytechnic Institute imeni S. Lazo; UDC 06.3]

[Abstract] The importance of lowering the lasing action threshold of quantum dimensional lasers to fractions of a milliampere for using them in optical data processing and data transmission systems is discussed and the need to examine these lasers' dynamics is emphasized. Transient processes in an AlGaAs laser with a <2 mA threshold current are examined and single-frequency lasing under deep pulse modulation of the pump current is reported. The original heterostructures with a single 15 nm dia. quantum well are grown by the low-temperature liquid-phase epitaxy method. A sectional cavity made from a planar mirror installed on a miniature piezoelectric ceramics plate is used for longitudinal mode discrimination near the high-transmission laser mirror. The aperture's time resolution is at least 0.2 ns; the lasing action threshold decreased by almost 10 percent in the presence of the external mirror. Emission spectra of the laser in the CW and pulsed mode and oscillograms of the laser's light response to current pulses of various durations are plotted. The use of the quantum-dimensional structure together with the sectional cavity makes it possible to produce a single-frequency spectrum without a constant shift—an important feature for using such lasers in data processing devices. Figures 2; references 7: 5 Russian, 2 Western.

Shock Wave Structure in Gaseous Mixture

927J0161B Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 8, Aug 91 pp 33-42

[Article by A.M. Bashlykov, V.Yu. Velikodnyy; UDC 03]

[Abstract] The physical processes occurring in the shock wave profile in a two-component mixture of monoatomic gases with substantially differing molecular masses are investigated; in so doing, special emphasis is placed on examining the structure of shock waves in the case of low heavy component concentrations at a close-to-unity ratio of the mass densities of light and heavy particles. The task is reduced to solving a system of Boltzmann rate equations by the Mott-Smith method generalized for the case of gas mixtures using an approach which makes it possible to eliminate a number of assumptions made is earlier analyses. Partial concentration, temperature, and viscous stress profiles are plotted and the heat flux is calculated. It is shown that domains where the heat flux sign is the same as that of the temperature gradient exist in the heavy component heat flux profile for a number of variables characterizing the mixture and its flow. A comparison to the results of numerical simulation by the Monte Carlo method and to experimental data reveals that the proposed technique produces an adequate outcome and may be used at the preliminary stage of studies aimed at identifying the physical patterns of the mixture behavior in the shock wave; the method does not call for considerable computer time outlays and is suitable for analyzing a large number of versions. Figures 5; references 21: 12 Russian, 9 Western.

Fast Finite-Amplitude Magnetosonic Waves in Rarefied Plasma

927J0164B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 1, Jan 92 pp 89-98

[Article by A.V. Danilov, High Temperatures Institute at Russia's Academy of Sciences]

[Abstract] Nonlinear waves in rarefied plasma, particularly periodic low-frequency waves (NChV) in rarefied plasma, and their manifestations are discussed and traveling periodic fast magnetosonic waves (BMZ) are considered in the framework of single-fluid plasma hydrodynamics. In so doing, it is assumed that the wave propagation angles relative to the magnetic field are not too close to $\pi/2$, so dispersion is determined by the finiteness of the ionic Larmor radius. The fast magnetosonic waves are considered in the framework of the effective potential whereby the wave amplitude is determined by a parameter proportionate to the wave energy flux and its frame of reference. The conditions under which a rotational discontinuity appears in the wave structure are formulated. The findings are compared to the experimental and theoretical low-frequency wave parameters in the area on the leading edge of the bow shock wave of planets and comets and the results produced in a study of model equations derived by modifying Schroedinger's nonlinear equation. Figures 5; references 20: 6 Russian, 14 Western.

Nonlinear Electromagnetic Longitudinal Ultrasound Generation in Zinc

927J0177C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 2, Feb 92 pp 671-681

[Article by A.N. Vasilyev, Yu.P. Gaydukov, M.I. Kaganov, Ye.G. Kruglikov, Moscow State University imeni M.V. Lomonosov]

[Abstract] Studies in the area of electromagnetic-acoustic transformation and the mechanism of linear transformation responsible for ultrasound generation in metal at the frequency of the electromagnetic wave incident upon its surface are reviewed and it is speculated that generation of longitudinal ultrasound at the doubled incident electromagnetic wave frequency may be due to a force caused by the appearance of thermoelastic stresses in the skin-layer

when Joule's heat is released in it. The phenomenon of nonlinear generation of longitudinal ultrasound in single crystals of zinc within a temperature range encompassing the domains of normal and abnormal skin effects in this metal is investigated. The measurements are taken within a 0-40K temperature range in single crystal plane-parallel zinc wafers made from a massive block by spalling along the hexagonal plane. The temperature dependence of the acoustic resonance amplitude and reciprocal attenuation and the temperature dependence of the nonlinear longitudinal ultrasound generation in Zn at various frequencies are plotted and it is shown that the temperature progress of the generation efficiency can be described with the help of three principally different transformation mechanisms—inductive, thermoelastic, and straining. The inductive mechanism's efficiency is virtually independent of temperature under the experimental conditions while the thermoelastic mechanism's efficiency decreases with temperature. The electron straining mechanism's efficiency increases with a decrease in temperature. The results of electromagnetic ultrasound excitation in both linear and nonlinear transformation modes under abnormal skin effect conditions demonstrate that the straining mass (electron-phonon coupling) consistently exceeds the free electron mass by an order of magnitude. The authors are grateful to V.I. Khizhnyy for stimulating remarks and to M.A. Gulyanskiy, N.M. Makarov, and V.Ya. Yampolskiy for constructive discussions. Figures 7; references 34: 20 Russian, 14 Western.

CaF_2-SrF_2 Stressed Layers and Superlattices on Si and GaAs

927J0107B Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 21, Nov 91 pp 28-32

[Article by J.C. Alvarez, S.V. Novikov, N.S. Sokolov, N.L. Yakovlev; UDC 06.2; 06.3; 07; 12]

[Abstract] The characteristic features of epitaxial layers of calcium and strontium fluorides grown by the molecular beam epitaxy (MLE) method on semiconductors are discussed; oscillations of the fast electron diffraction (DBE) intensity in the process of epitaxial growth of CaF_2 and SrF_2 are studied and the low-temperature photoluminescence spectra of Sm^{2+} ions are examined in order to assess the possibility of coherent growth of fluoride layers in such a highly mismatched heterojunction. The dependence of the 00 reflection intensity in the fast electron diffraction pattern on time during the $SrF_2/CaF_2/Si$ structure and superlattice growth and photoluminescence spectra of Sm^{2+} ions at 1.8K in various superlattices are plotted. The results of the analysis demonstrate that by selecting the conditions of molecular beam epitaxy growth, it is possible to grow both fully and partially coherent stressed fluoride structures and superlattices on Si(111) and GaAs(111) which are interesting from the viewpoint of both practical applications and basic research in the field of low-temperature physics. The authors are grateful to V.V. Ovsyankin for discussing the findings, Ye.F. Martynenko for help with preparing the samples, and A.A. Kaplyanskiy for support. Figures 3; references 6: 2 Russian, 4 Western.

New Electron Phenomena in Semiconductor-Magnetic Semiconductor Quantum Structures

927J0110C Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 54 No 8, Oct 91 pp 449-452

[Article by Yu.I. Balkarey, V.N. Lutskiy, V.A. Petrov, Radio Engineering and Electronics Institute, Fryazino, Moscow oblast]

[Abstract] The characteristics of semiconductor/magnetic semiconductor (MP)-based quantum structures in which magnetic superconductor layers may play the role of both barriers and quantum wells (KYa) which make it possible to change the energy spectrum of quasiparticles in the magnetic semiconductor by manipulating the magnetic field strength and temperature thus affecting the properties of the entire structure are discussed and a number of new phenomena developing in quantum structures with magnetic semiconductors when the latter are magnetized are considered. It is noted that in single heterostructures of the magnetic semiconductor/semiconductor type where a two-dimensional electron channel has been developed in the nonmagnetic material, the magnetic semiconductor's magnetization cardinally modifies the energy spectrum of 2*D* gas in a conventional semiconductor as well as all its relevant physical properties. Figures 2; references 9: 1 Russian, 8 Western.

Neutron Diffraction Pattern Refinement of Nonlinear Optical Crystal of $Cs_2UO_2Cl_4$ Dicesiumuranyltetrachloride

927J0132B Moscow KRISTALLOGRAFIYA in Russian Vol 36 No 5, Sep-Oct 91 pp 1135-1138

[Article by A.G. Tutov, V.P. Plakhtiy, O.A. Usov, R.A. Bublyayev, Yu.P. Chernenko, Engineering Physics Institute imeni A.F. Ioffe; UDC 548.312.4.06:539.125.5]

[Abstract] Attempts to refine the dicesiumuranyltetrachloride crystal structure using a biaxial neutron diffractometer at a 1.101 angstrom unit wavelength with 467 independent reflections are described. The integrated intensity of a cut $Cs_2UO_2Cl_4$ crystal is measured in a monochromatic neutron beam; the wide disorientation range of the crystal's mosaic structure blocks and the relatively short neutron wavelength make it possible to ignore extinction. The coordinates of the basal atoms and anisotropic thermal parameters of the compound are summarized and a projection of the $Cs_2UO_2Cl_4$ structure upon the *ac* plane is plotted. The uranyl, cesium, and oxygen atoms are located on the *m* perpendicular to *b* planes of symmetry and alternate with chlorine atom layers. It is noted that dicesiumuranyltetrachloride is the first crystal whose unknown cluster of points is established from the angular dependence of the second optical harmonic and the only nonlinear optical crystal containing an actinoid group element. The authors are grateful to V.A. Frank-Kamenetskiy for interest in the effort. Figures 2; tables 3; references 3: 2 Russian, 1 Western.

Interrelation of 1/*f* Noise and Nonlinearity Phenomena in Metallic Films

927J0135B Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 54 No 9, Nov 91 pp 510-513

[Article by G.P. Zhigalskiy, Moscow Electronic Engineering Institute]

[Abstract] The origin of electric fluctuations with the 1/*f* spectrum in metal films is discussed and efforts to clarify the 1/*f* noise development mechanism in solid metallic films are described. To this end, 50 nm—1 μm thick Mo, Ta, and Cr films deposited on glass and oxidized silicon substrates are investigated. The spectral power density (SPM) of the 1/*f* noise is measured by the direct method in a 2 Hz—10 kHz band at a direct current density of $\leq 10^5$ A/cm^2 and the volt-ampere characteristic irregularity is determined by the third harmonic method under the effect of a harmonic test signal at a 10 kHz frequency and a 10^{-5} W power. In addition, internal mechanical stresses are measured by bending the cantilever-constrained substrate. The study reveals an interrelation between the 1/*f* noise and the cubic

nonlinearity of the volt-ampere characteristic in solid metallic films and demonstrates that the $1/f$ noise and nonlinearity phenomena in films with an elevated mobile defect concentration develop as a result of the conductivity modulation processes due to the vacancy production and annihilation in various types of sinks; within the film volume, grain boundaries and micropore surfaces serve as the principal sinks or sources of vacancies. Figures 1; references 13: 8 Russian, 5 Western.

Nonlinear Stationary and Nonstationary Light Propagation in Semiconductor Under Resonant Exciton Excitation

927J0156A Leningrad FIZIKA TVERDOGO TELA in Russian Vol 33 No 8, Aug 91 pp 2250-2257

[Article by B.Sh. Parkanskiy, A.Kh. Rotaru, Applied Physics Institute at the Moldovan Academy of Sciences, Kishinev; UDC 537.311.33]

[Abstract] The nonlinear effects developing in semiconductors exposed to high-power light sources and optical bistability and self-pulsations are discussed and the nonlinear stationary and nonstationary light transmission through a semiconductor during the resonant high-density exciton excitation in the ring vibrator geometry is examined theoretically. The study is a logical extension of earlier efforts in a new experimental configuration. The theory of stationary and nonstationary light propagation in a ring vibrator is developed on the basis of Keldysh's (or Ginzburg-Landau) generalized equations for coherent phonons and excitons allowing for the exciton-exciton interaction and it is shown that under certain conditions, a negatively sloping section, the so-called instability window, appears on the vibrator transmission curve. These windows are responsible for the development of periodic and stochastic self-sustained fluctuations. The power spectrum of the corresponding oscillations is plotted and it shown that the transition to chaos occurs through period doubling bifurcations. Oscillation phase trajectories which represent complex limiting cycles and strange attractors are plotted and it is demonstrated that the system may operate as a converter of steady-state light to fluctuating radiation. A new class of order-to-chaos transition in the form of moving transition fronts is discovered; it is noted that similar phenomena may occur in a system of coherent excitons and phonons; in addition to dynamical turbulence, the development of turbulence in space and formation of order-to-chaos and chaos-to-order structures due to the flop wave is also possible. Semiconductors with the above nonlinearity mechanism may also be used for developing an optical logic cell with a short operate time. Figures 7; references 23: 13 Russian, 10 Western.

Local Impurity Center Structure Ordering in YAG Crystals

927J0156B Leningrad FIZIKA TVERDOGO TELA in Russian Vol 33 No 8, Aug 91 pp 2268-2272

[Article by M.V. Korzhik, M.G. Livshits, V.B. Pavlenko, M.L. Meylman, Scientific Research Institute of Nuclear problems at the Balarusian University imeni V.I. Lenin, Minsk; UDC 535.33/34]

[Abstract] The issue of "nonstatic" impurity center distribution in crystals is addressed and it is shown that the number of complex impurity center associates may be quite high, depending on the selection of the matrix and doping elements which form crystals lattices with are isostructural with the matrix; in a number of cases, these associates play a dominant role in the center-to-center energy transfer. Using the example of yttrium-aluminum garnet crystals (IAG) activated with iron (YAG:Fe^{3+}, etc.) and rare earth element (RZE) impurities, the non-equiprobable volume distribution of the impurity centers is demonstrated for the first time for isostructural dopant lattices. The crystal samples are grown by the vertical oriented crystallization method from molybdenum containers and by Czochralski's method from iridium crucibles. The luminescence kinetics are measured by an improved PRA3000 spectral fluorometer within a $(1\text{-}1 \times 10^{-4})I_0$ intensity range. This phenomenon of localized structural ordering is important for other crystalline matrices used in laser technology, e.g. crystals with a perovskite and olivine structure, as well as single crystal scintillators where by selecting the coactivators one can modify the local structure and, consequently, increase the rate of excitation transfer to the scintillation centers. The authors are grateful to Kh.S. Bagdasarov and B.I. Minkov for providing activated crystal samples. Figures 4; references 13: 12 Russian, 1 Western.

New Type of Inhomogeneous Spin-Spin Resonance Induced by Magnetic Film's Insulating Coat

927J0156C Leningrad FIZIKA TVERDOGO TELA in Russian Vol 33 No 8, Aug 91 pp 2290-2292

[Article by S.V. Tarasenko, Donetsk Engineering Physics Institute at the Ukrainian Academy of Sciences]

[Abstract] The resonant interaction of the traveling surface (bulk) magnetostatic and bulk exchange spin waves—the inhomogeneous spin-spin resonance (NSSR)—and new types of nonexchange spin oscillations, the elastostatic spin waves (ESV) similar to magnetostatic spin waves (MSV), are discussed and an attempt is made to find the necessary conditions under which the joint effect of the magnetoelastic and inhomogeneous exchange interaction in an elastostatic limit leads to the formation of a new type of inhomogeneous spin-spin resonance in a bounded magnetic material: resonant interaction of the traveling surface nonexchange elastostatic and bulk exchange spin waves. For illustration, a two-layer antiferromagnetic-dielectric structure is examined. The importance of acoustic contact of the antiferromagnetic (AFM) film with the dielectric base is emphasized due to the fact that the above type of magnetic resonance is not realized in the case of a free magnetic slab. The author is grateful to Ye.P. Stefanovskiy for constructive discussions. References 7: 6 Russian, 1 Western.

Spiral Solitons in Ferromagnetic

927J0156D Leningrad FIZIKA TVERDOGO TELA in Russian Vol 33 No 8, Aug 91 pp 2316-2319

[Article by A.B. Borisov, V.A. Feygin, B.N. Filippov, Physics of Metals Institute at the Siberian Department of the USSR Academy of Sciences, Sverdlovsk; UDC 538.221]

[Abstract] A new phenomenon—the initial labyrinth domain structure is substantially modified and helical formations are observed in the sample with the help of Kerr's magnetooptical effect—appearing in ferromagnetic materials whose axis of easy magnetization (OLN) is perpendicular to the surface in the presence of an external magnetic field directed along this axis is discussed; attention is focused on the fact that the Landau-Lifshits equation permits the existence in uniaxial ferromagnetics of nonlinear helical waves which are similar to the ones observed in *ZhETF* Vol. 97 No. 4, 1990, pp. 1218-1230. It is assumed that in the magnetically uniaxial ferromagnetic with an axis of easy magnetization directed along the *z*-axis, the maximum value of the *H(t)* amplitude is comparable to the sample saturation field. Nonlinear low-amplitude helical perturbations in a uniaxial ferromagnetic are described allowing for relaxation and the principal possibility of stabilizing them by external pumping or by selecting the alternating field configuration is demonstrated. References 8: 6 Russian, 2 Western.

Nonlinear Transmission Dynamics and Nonlinear Susceptibility of Semiconductor Microcrystals (Quantum Dots)

927J0164C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 1, Jan 92 pp 270-283

[Article by Yu.V. Vandyshev, V.S. Dneprovskiy, V.I. Klimov, Moscow State University imeni M.V. Lomonosov]

[Abstract] The energy spectrum and nonlinear phenomena of semiconductor microcrystals—quasinull-dimensional structures (quantum dots)—are discussed and the nonlinear transmission spectra dynamics of microcrystal-doped CdSe glass are investigated. A dimensional quantization level structure not found in linear transmission spectra is manifested in the glass due to selective excitation of microcrystals of a certain radius. The spectra of induced absorptance variations—bleaching peaks—are recorded and used to determine the induced refractive index variance and the spectra of the real and imaginary parts of cubic susceptibility. The effect of the microcrystal dimensions and carrier life on the characteristic values of nonlinear optic constants is examined in the case where the microcrystal radius does not exceed Bohr's exciton radius. The transmission recovery dynamics are attributed to the filling of dimensional quantization levels with carriers excited by picosecond laser pulses. Gain is recorded for the first time in quasinull-dimensional semiconductor structures. Figures 4; references 18: 5 Russian, 13 Western.

On One Possibility of Improving Scanning Rate of TEA-CO_2 Laser With Liquid Crystal Space-Time Light Modulator

927J0107C Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 21, Nov 91 pp 58-60

[Article by V.V. Danilov, O.B. Danilov, A.I. Sidorov; UDC 06.3; 07; 12]

[Abstract] The effect of liquid crystal (ZhK) sluggishness on the switching rate of spatial modes in a laser with a matched cavity and an intracavity liquid crystal space-time light modulator (PVMS) is discussed and the possibility of increasing the scanning speed by utilizing the so-called transient condition in the cholesteric-nematic junction (KhNP) in a TEA-CO_2 laser is investigated. In this condition, the liquid crystal modulator's scattering ability decreases monotonically with an increase in the control voltage, making it possible gradually to manipulate the intracavity losses and thus control the time position of the stimulated emission pulse relative to the start of the discharge in the active medium; the slope of the time pulse position vs. voltage curve is 10-50 ns/V. The use of the above condition makes it possible to shorten the spatial mode switching time to 200 ns and control it smoothly within 1.5 μs. A decrease in the lasing pulse amplitude with an increase in the time shift may be compensated for by using an amplifier whose saturation level corresponds to the minimum lasing pulse power. Figures 1; references 2.

Exciting Optostructural Instability in Biological Liquid by Low-Intensity Laser Pulse

927J0107D Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 21, Nov 91 pp 66-70

[Article by S.A. Skopchinov, Ye.B. Volf, S.A. Kurochkin; UDC 03; 07]

[Abstract] The likely physical mechanisms of the biological impact of low-intensity laser radiation are discussed and a new principally important pattern—delayed reaction of biomolecular solutions to a short radiation pulse manifested as changes in the structural-optical characteristics of these media regardless of their molecular composition—is investigated. A solution of albumin made by Reanal in an isotonic physiological solution of 0.9 percent NaCl made by Polfa and human blood serum produced by standard coagulation are used as the object of inquiry while an LG-75/1 He-Ne laser emitting on a 628.8 nm wavelength with an output power of 30 mW and a focused beam power density of 200 mW/cm^2 is used as the radiation source. The testing procedure is outlined and the behavior of the liquid's refractive index during CW and single pulse irradiation and the dependence of the reciprocal value of the time of extreme refractive index change in the irradiated liquid on the laser radiation power density are plotted. An analysis shows that a characteristic dynamical instability appearing as a curve with a maximum develops in the solution at a certain interval after irradiation; the reciprocal value of this time is a function of radiating power and its slope is determined by the characteristic features of the sample; and the extremal changes in the *n(t)* function developing over a 10-15 min interval are observed both after CW irradiation and a short 1-2 s pulse. The reaction of biological liquids to short pulses makes it possible to raise the issue of reexamining traditional CW irradiation modes during the intravenous laser therapy. Figures 2; references 17: 16 Russian, 1 Western.

Active Media Diagnostics of Homogeneous and Mixture Gas Dynamic Lasers Using Probing CO_2 Lasers Tunable in Traditional and Nontraditional Band Lines

927J0116A Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 18 No 9(231), Sep 91 pp 1060-1062

[Article by Yu.N. Bulkin, Yu V. Kolobyanin, Yu.V. Savin, V.A. Tarasov; UDC 621.373.826.038.823]

[Abstract] The limitations of inverse active media parameter diagnostics based on the amplification spectrum obtained by retuning a CO_2 laser in traditional lines and the stringency of the requirements imposed on the resonator for stimulating stable probing laser emission in nontraditional lines are discussed. A CW probing CO_2 laser tunable in five band lines (OO^01-10^00, 00^01-02^00, 01^11-11^10, 00^02-10^01, and 00^02-02^01) is described and its optical train is cited; a laser spectrograph for investigating active media of homogeneous and mixture gas dynamic lasers (GDL) is designed on its basis and tested using a unit employing electric explosion in a confined chamber in order to heat the gas; the translational and vibrational temperature and concentration of active CO_2 particles are measured and the measurement results are compared to analytical data, showing a good consistency (4 percent). The maximum spread of the experimental and theoretical values does not exceed 10 percent. Figures 3; references 5.

Emission Tests of New Erbium Laser Glasses

927J0116B Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 18 No 9(231), Sep 91 pp 1063-1065

[Article by B.I. Denker, G.V. Maksimova, V.V. Osiko, S.Ye. Sverchkov, Yu.Ye. Sverchkov, General Physics Institute at the USSR Academy of Sciences, Moscow; UDC 621.373.826.038.825.2]

[Abstract] The unique properties of erbium laser glasses—practically the only laser medium whose emission wavelength falls within the absorption band of OH-groups, i.e., 1.5-1.6 μm—are discussed and emission tests of new types of glass in the free lasing condition are reported; the new glasses' emission characteristics are compared to the relevant properties of known erbium

glasses—the KGSS-0135/153 and LGS-Kh. The chemical composition and activator concentration of the glasses under study and the emission test conditions are summarized and the comparative emission characteristics of active elements (AE) of the new and traditional types of glass are plotted. The study demonstrates that the LSE-Kh and LSE-N glass noticeably exceed the commercial KGSS-0135/153 glass with respect to the principal emission characteristics and are at least as good as the LGS-Kh experimental glass while the emission and thermal strength characteristics of the LSE-3 glass attest to the fact that an efficient laser glass with high a temperature strength for operation in the periodically pulsed mode can be produced on the basis of glass with a high B_2O_3 concentration. Second generation LSE-Kh2 and LSE-N2 glasses exceed all other known types of glass with respect to the lasing-action threshold and thermooptical characteristics by almost twofold. Figures 2; tables 3; references 5.

Numerical Simulation of High-Power Laser Beam Space-Time Structure

927J0116C Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 18 No 9(231), Sep 91 pp 1118-1121

[Article by A.A. Andreyev, P.I. Krepostnov, A.N. Sutyagin, A.N. Shatsev, State Optics Institute imeni S.I. Vavilov, Leningrad; UDC 621.373.826]

[Abstract] A new computer program ("Trakt") which makes it possible to analyze the temporal and spatial characteristics of a laser beam transmitted through a solid-state amplification system of a laser-based thermonuclear synthesis (LTS) device consisting, in addition to the amplifier, of spatial filters, air gaps, and other elements, as well as a phase correcting plate capable of modifying the spatial inhomogeneity of the beam on the target caused by the self-focusing and diffraction, is described. A physical-mathematical model of the amplification system and its block diagram are presented; the "Trakt" program was tested by analyzing the parameters of the NOVA unit and comparing them to the computation results obtained by the MALAPROP source code; the divergence between the theoretical and experimental data did not exceed 10 percent. The effect of the phase correcting plate on the laser radiation intensity distribution on the target surface is examined and the possibility of improving the target irradiation uniformity is demonstrated. Figures 6; tables 2; references 9: 7 Russian, 2 Western.

On Nonequilibrium Metal Heating by Picosecond Laser Pulse

927J0117A Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 17, Sep 91 pp 1-6

[Article by S.I. Anisimov, A.V. Barsukov, High Temperatures Institute at the USSR Academy of Sciences, Leningrad; UDC 01; 07]

[Abstract] The results of an analytical solution of the problem of metal heating by an ultrashort laser pulse obtained by Libenson (GOI imeni Vavilov, Leningrad, 1987) on certain simplifying assumptions are compared to the numerical solution of the complete problem. To this end, the heating of metal by an ultrashort pulse is described by a system of equations and the boundary value and initial conditions are defined assuming that $g(t)$=const, as in the original analytical solution. Calculations are performed for four sets of parameters which encompass the characteristic range of radiation intensity and correspond to the experimental parameters. The remaining parameters correspond to silver. The surface absorptance is approximated by a piecewise-linear function. The results show that despite the rather considerable initial assumptions, the original analytical solution successfully describes certain features of the complete set of equations and is suitable for quantitatively describing the initial phase of metal heating by a picosecond laser pulse. The applicability conditions of the analytical solution are determined. The authors are grateful to M.N. Libenson for constructive discussions. Figures 2; tables 1; references 9: 6 Russian, 3 Western.

Fractal Elasticity and Entropy Hyperelasticity Theory

927J0117C Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 17, Sep 91 pp 68-72

[Article by A.S. Balankin; UDC 01; 05.1]

[Abstract] The principal shortcomings of existing phenomenological modifications of the entropy theory and empirical models of the elastic potential used for interpreting experimental data on the straining of elastic materials are discussed and it is shown that the value of second-order elasticity parameters even in the limit of infinitely small strain calculated with the help of phenomenological relationships do not meet the conditions of the classical theory of elasticity due to the substantially nonGaussian statistics of real polymer nets and the inconsistency of the two principal postulates of the classical theory of entropy hyperelasticity, i.e., the elastic materials' Gaussian statistics and incompressibility. Consequently, a theory of elasticity and entropy hyperelasticity of fractals is formulated on the assumptions that during the straining of an elastically isotropic fractal under the effect of force, a sole new characteristic dimension develops and that under elastic deformation, the fractal's self-similarity is preserved, i.e., the law of the fractal density variation under elastic deformation is similar to the case of geometric change in dimensions. The dependence of the change in the fractal dimension in the force application direction on the force magnitude is plotted and the entropy change under elastic deformation of a d_f-dimensional fractal is calculated. It is noted that the new approach may be used even for formulating the theory of elasticity for multifractals. The authors are

grateful to A.L. Bugrimov, A.B. Mosolov, A.Ya. Sagomonyan, and Ye.A. Shemyakin for constructive discussions. Figures 1; references 10: 9 Russian, 1 Western.

Nonlinear Self-Consistent Theory of Free-Electron Lasers: Investigation Method

927J0129A Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Russian Vol 36 No 9, Sep 91 pp 1318-1325

[Article by V.V. Kulish, Sumy Physical Technology Institute; UDC 537.86+621.373]

[Abstract] The importance of developing the nonlinear theory underlying the design of free-electron lasers—expensive and powerful sources of coherent electromagnetic radiation in the millimeter and infrared bands—is emphasized and the basic premises of a new approach to developing the self-consistent nonlinear theory of superheterodyne and parametric free-electron lasers (LSE) are formulated on the basis of Bogolyubov's averaging methods and the slowly changing mode amplitude method. The laser is simulated by a relativistic electron beam (REP) drifting as a whole collinearly to the *z*-axis through a positive ionic background while the beam space charge is assumed to be fully equalized. The beam is further assumed to be quasinonequilibrium; the Boltzmann rate equation and Maxwell's system of equations are jointly solved for the beam. The relativistic electron beam movement in given fields and the electromagnetic wave excitation during a given electron movement in the relativistic beam are considered. The possibility of taking into account resonances related to the latent electron movement periods and wave field and electron oscillation harmonic resonances in intrinsic and external fields is demonstrated. The author is grateful to S.S. Moiseyev for interest in the effort and constructive discussions. The efficiency and applications of the approach will be demonstrated in follow-up articles. References 21.

Effect of Focusing and Defocusing on Light Absorption Saturation

927J0129B Kiev UKRAINSKIY FIZICHESKIY ZHURNAL in Ukrainian Vol 36 No 9, Sep 91 pp 1328-1332

[Article by N.P. Kulish, V.P. Kunets, M.P. Lisitsa, N.I. Malysh, V.I. Rykov, V.N. Sokolov, Semiconductors Institute at the Ukrainian Academy of Sciences, Kiev; UDC 535.34; 621.315.592]

[Abstract] The methods of decreasing the energy necessary for switching an optical gate, such as a bistable element formed by the mirrors of the Fabry-Perot interferometer with the help of various focusing systems and lenses are discussed and the effect of optical radiation focusing and defocusing on the semiconductor light absorption saturation, i.e., on the slope of the sample translucence increase when optical absorption is reaching saturation, is investigated using a level, two-band model of a direct-gap semiconductor. Analytical and experimental studies show that compared to a parallel light beam, focusing increases the slope of transmission curve while defocusing decreases the curve slope. Experiments with $Cd_{0.1}Se_{0.9}$-doped KS-19 glass confirm the findings. Figures 4; references 12: 7 Russian, 5 Western.

Stimulated Emission of Single-Frequency High-Power Microsecond Pulses by Ruby Laser

927J0130A Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 18 No 11(233), Nov 91 pp 1286-1290

[Article by V.G. Gladyshev, K.G. Folin, Electrometry Automation Institute at the Siberian Department of the USSR Academy of Sciences, Novosibirsk; UDC 621.373.826.038.825.2]

[Abstract] Stimulated emission of single-frequency high-power pulses of visible light by argon lasers is reported and the possibility of developing a similar source on the basis of a ruby laser is investigated. To this end, two solid-state laser emission modes in which nanosecond pulses can be generated are examined: conventional free running and slow cavity Q-switching. As a result, reproducible single-frequency stimulated emission of a ruby laser is realized in the form of a smooth pulse with a 2-10 μs duration at half power level and a power of up to 10 kW. It is shown that the mode competition has a definitive effect on the ruby laser emission intensity kinetics and spectrum under slow cavity Q-switching. Smooth 1-10 μs pulses with a close to 10^{-4} cm^{-1} bandwidth are generated. The possibility of quasistationary stimulated single-mode emission in the free running operation (single-frequency emission) with an up to 300 μs duration and a radiating power of over 100 W is demonstrated; the importance of the resulting data for high-speed interferometry is emphasized. The authors are grateful to O.A. Gorin for help with the experiment and I.V. Nalivayko for performing numerical analysis on a computer. Figures 6; references 19: 17 Russian, 2 Western.

On Possibility of Developing CW Laser With Radioactive Isotope Pump Source

927J0130B Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 18 No 11(233), Nov 91 pp 1297-1299

[Article by A.M. Voinov, A.I. Konak, S.P. Melnikov, A.A. Sinyavskiy, All-Union Scientific Research Institute of Experimental Physics, Arzamas, Nizhniy Novgorod oblast; UDC 621.373.826]

[Abstract] The possibility of using various nuclear power sources, e.g., radioactive isotopes, for laser pumping—pumping gaseous lasers by products of nuclear reactions—is discussed and a low-threshold Ar-Xe gaseous mixture laser excited by fragments of uranium fission is examined. The possibility of pumping such a laser by

radioactive sources is investigated on the basis of experimental data. To this end, a quasi-CW low-threshold Ar-Xe laser emitting on 2.03 and 2.65 μm wavelengths is studied; at an Ar:Xe=400:1 ratio and a 0.25 atm pressure, the lasing threshold on the former wavelength is reached at a thermal neutron flux density of 1.5×10^{12} $(cm \times s)^{-1}$ which corresponds to a specific pump power of close to 0.02 W/cm^3. Thus, the possibility of pumping lasers by α-particles from ^{210}Po and ^{242}Cm radioactive sources is shown. To increase the normal service life of a radioactive isotope-pumped laser, it is necessary to use isotopes with a long half-life period yet their use calls for searching for laser media with lower lasing threshold. Figures 2; tables 1; references 18: 8 Russian, 10 Western.

Emission Tests of New Neodymium Laser Glasses

927J0130C Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 18 No 11(233), Nov 91 pp 1303-1305

[Article by P.V. Gorbunov, B.I. Denker, N.N. Ilichev, A.K. Kiryanov, G.V. Maksimova, V.V. Motsartov, V.V. Osiko, S.Ye. Sverchkov, Yu.Ye. Sverchkov, V.N. Yakimenko, General Physics Institute at the USSR Academy of Sciences, Moscow; UDC 621.373.826.038.825.3]

[Abstract] The principal requirements imposed on solid-state glass lasers for medical and process applications, e.g., high mean power and angular radiating intensity at a high efficiency (KPD), and the requirements imposed on glass in order to meet them—the high temperature resistance and sufficient light absorptance in the case of relatively thin active elements (AE) and a high quantum yield of the neodymium atom luminescence—are discussed. The possibility of developing glass whose thermal optical characteristics exceed those of the KNFS concentrated phosphate glass and which is at least equal to it with respect to all other parameters, and glass with an elevated efficiency at high pump levels, is investigated. Several glass compositions are synthesized and emission test conditions of the synthesized glasses are summarized. The stimulated emission curves of the KNFS and newly synthesized glass are plotted and the active element breakdown threshold power is analyzed. The athermal LSN-T neodymium glass is highly efficient at high pump levels. Figures 1; tables 4; references 4.

High-Power Single Quantum Well AlGaAs/GaAs Injection Laser With Broad Junction and Pencil-Beam Radiation Pattern

927J0130D Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 18 No 11(233), Nov 91 pp 1313-1314

[Article by O.V. Danilina, A.Ye. Kosykh, A.S. Logginov, S.A. Pashko, Moscow State University imeni M.V. Lomonosov; UDC 621.373.826.038.825.4]

[Abstract] Recent improvement and advantages of multielement phased injection lasers (MFIL) and single quantum well injection lasers (IL) with a broad junction which emit radiation with a high degree of spatial coherence are discussed and the spatial and spectral emission characteristics of single quantum well AlGaAs/GaAs injection lasers with a broad junction produced by chemical precipitation of organometallic compounds from the gaseous phase with a 20 nm active area are investigated in a pulsed mode with a 200 ns pulse at a 100 Hz repetition frequency. A 600 μm long and 200 μm wide cavity is used for this purpose. The radiation pattern divergence is equal to the 0.5° limit of diffraction near the lasing threshold and increases by 50 percent when the threshold is exceeded by a threefold. At a thrice the threshold current, the radiating power in the pulsed mode is equal to 150 mW. The Teleglaz-M system is used in the light field photometry and digital processing. Figures 2; references 7: 3 Russian, 4 Western.

Effect of Intracavity Stimulated Raman Scattering on Self-Modulation of Supershort Pulse Ring Laser

927J0130E Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 18 No 11(233), Nov 91 pp 1359-1361

[Article by Yu.N. Yashkir, O.V. Yashkir, Kiev Polytechnic Institute; UDC 535.375.5:621.373.826]

[Abstract] Stimulated emission features of lasers with an intracavity nonlinear optical conversion, such as second harmonic generation (GVG), are discussed and the stimulated emission characteristics of a ring picosecond pulse laser with an intracavity stimulated Raman amplification (VKU) of Stokes pulses are investigated theoretically, allowing for the regenerative Stokes frequency feedback, using four approximations. Typical lasing conditions—the stable, regular unstable, and irregular unstable modes—are examined on the basis of a numerical analysis of attractors and bifurcations. The latter mode represents an area of optical turbulence. When the nonlinearity parameters is manipulated, the laser displays "intermittency" areas. The outcome of the study may be used for analyzing data and developing ring ultrashort pulse (UKI) lasers with nonlinear losses which are determined by stimulated Raman scattering (VKR). Figures 5; references 5: 4 Russian, 1 Western.

Scattering Characteristics of Focused Laser Beams on Moving Rough Surface

927J0143A Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 6, Jun 91 pp 106-112

[Article by S.S. Ulyanov, Mechanical Engineering Institute imeni A.A. Blagonravov at the USSR Academy of Sciences, Saratov; UDC 07]

[Abstract] The dynamics of developed speckle fields on the moving rough surface and the characteristics of scattered laser fields are discussed and the characteristics of dynamic scattering of a focused laser beam on a surface with a surface profile irregularity height commensurate with the wavelength are investigated; in addition, the functional dependence of the scattered wave

intensity variation on the surface profile when the surface is scanned by a focused laser beam is established. To this end, the problem of Gaussian beam diffraction on a rough surface is solved by the perturbation method and the scattered wave structure is separated into the specular and random components by formally separating the spatial process frequency spectrum describing the surface profile into low- and high-frequency components. The specular and random component interaction is described by an interference equation. The dynamical scattering equation of Gaussian beams with a small constriction on a rough surface is formulated in the Fraunhofer diffraction approximation and the conditions under which weakly developed speckle structures form are examined. The dependence of the correlation length of the process on the parameters determining the radiation scattering is plotted. The principal effects observed in the experiment follow from the theoretical analysis of the dynamical scattering processes. Since the relationship between the change in the scattered wave intensity and surface profile is functional, the dynamics of a light field with a weakly developed speckle structure can indeed be used for determining the scattering surface quality. The author is grateful to V.P. Ryabukho for discussing the findings. Figures 4; references 8: 6 Russian, 2 Western.

Characteristics of Speckle Fields Formed During Focused Laser Beam Scattering

927J0143B Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 6, Jun 91 pp 113-117

[Article by S.S. Ulyanov, Mechanical Engineering Institute imeni A.A. Blagonravov at the USSR Academy of Sciences, Saratov; UDC 07]

[Abstract] The speckle structures forming on an isotropic rough surface during the diffraction of laser beams whose parameters greatly exceed the dimensions of the surface irregularities and the light wavelength is discussed and the characteristic features of light fields with a low speckle modulation which form during the scattering of laser beams focused on a rough surface are analyzed. In so doing, the process of diffraction of a Gaussian beam normally incident upon an isotropic perfectly reflecting rough surface is considered assuming that the beam constriction plane coincides with the underlying plane and the scattering process is determined by a nondimensional parameter. The similitude criteria which reflect the principal features of focused laser beam scattering are analyzed and the results of a numerical solution of the problem of focused laser beam diffraction by a stationary rough surface are discussed. The dependence of the RMS perturbation on the distance between the observation plane and the scattering surface, the dependence of the RMS perturbation on the correlation length/constriction radius ratio, the dependence of the RMS perturbation on the scattering surface roughness, and the dependence of the RMS perturbation on the normalized constriction radius are plotted. The principal patterns of spatial speckle structure formation with low amplitude modulation are identified. The patterns established as a result of the experimental investigation and numerical analysis of the focused laser beam diffraction on smooth surfaces make it possible to evaluate the fine spatial high-frequency structure of the scattering surface from the depth of the speckle field amplitude modulation. The author is grateful to V.P. Ryabukho for discussing the findings. Figures 6; references 6: 5 Russian, 1 Western.

Bistable and Self-Sustained Oscillation Conditions During Mode Interaction in Nonlinear Semiconductor Interferometer

927J0143C Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 6, Jun 91 pp 175-178

[Article by Yu.I. Balkarey, A.S. Kogan, Radio Engineering and Electronics Institute at the USSR Academy of Sciences, Fryazino Branch; UDC 06; 07]

[Abstract] Excitation conditions in a bistable Fabry-Perot semiconductor interferometer and the results of mode competition in it are addressed and the results of a numerical simulation of this system are discussed for the purpose of establishing the possibility of controlling the self-sustained fluctuation frequency within a broad range with changes in the external wave intensity. A mathematical model of the bistable Fabry-Perot semiconductor interferometer with a concentrational optical nonlinearity mechanism and a mode competition, leading to self-sustained fluctuations of the nonequilibrium charge carriers in the semiconductors and the related stimulated laser emission fluctuations as well as the external wave transmission and reflection fluctuations of the resonator, is derived. The mode competition is due to the interaction of the mode excited by the external monochromatic wave and the laser mode generated in the semiconductor which serves as an optical pump relative to the former mode. An S-shaped transmission curve with an unstable upper branch is plotted and it is noted that in interferometers with an inertial optical nonlinearity mechanism, high-frequency self-sustained transmission fluctuations may also exist in the single-mode case; the corresponding instability is also realized in the upper optical hysteresis loop. Figures 3; references 4: 1 Russian, 3 Western.

On Efficiency Limit of Free Electron Laser With Longitudinal Magnetic Field

927J0151C Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 7, Jul 91 pp 151-156

[Article by V.A. Bazylev, A.V. Tulupov, Atomic Energy Institute imeni I.V. Kurchatov, Moscow; UDC 09; 10]

[Abstract] The issue of maximizing the efficiency (KPD) of free electron lasers (LSE) while maintaining a large Doppler frequency conversion and the positive effect of the presence of a longitudinal magnetic field in the free

electron laser (often referred to as an ubitron) are discussed; the field makes it possible to manipulate the inertial bunching pa.ameter which has a direct effect on laser efficiency. It is shown that the unidimensional theory describing the interaction of electrons with the ubitron wave correctly describes the tendency toward an increase in efficiency with a decrease in the parameter Φ which is proportionate to the nonisochronism parameter v; within a range of low Φ values, the theory is invalid since the particles are not bunched in this domain and efficiency η tends to zero. The value of efficiency peaks on the applicability boundary. The applicability limits of the unidimensional theory in the Raman and Compton mode with a high pumping energy are compared. Figures 3; references 10: 5 Russian, 5 Western.

Simple Method of Focusing Laser Radiation Onto Channel Waveguide Surface

927J0160A Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 20, Oct 91 pp 1-5

[Article by V.A. Sychugov, A.Ye. Tikhomirov; UDC 07]

[Abstract] The difficulties of driving optical waveguides by prismatic and grating coupling elements and the shortcomings of the cylindrical lenses in the case of sloping beam incidence—the general case of incidence—due to the fact that the total width of the transverse field distribution differs along the channel waveguide are discussed and it is shown that a cylindrical lens with a variable focal length is necessary for exciting channel waveguides at other than normal incidence angles. Simple geometric considerations show that a cone with a total opening of 2α subsequently polished off so as to ensure that the angle θ between the cone generator and its polished-planar section is equal to the incidence angle φ. A diagram of the mutual position of the conical lens and the channel waveguide is cited and the dependence of the beam deflection ψ on the transverse focusing element displacement in the base plane at various values of the x-coordinate is plotted. In the case of a prismatic radiation injection into the channel waveguide, the conical lens may simultaneously serve as the prism and focusing element. The results of an experiment to collimate 0.63 μm radiation extracted from a fiber with a lapped lateral surface and diffraction grating formed on it are described. An analysis demonstrates that the proposed method of focusing optical radiation onto the channel waveguide surface makes it possible to match it with bulk light waves efficiently and rather simply and is not too sensitive to the focusing element displacements and angular misalignment; the method may be successfully used for virtually any type of channel waveguide. Figures 2; references 3.

Spherical Mirror Analyzer of Charged Particle Beams

927J0107A Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 21, Nov 91 pp 1-3

[Article by V.V. Zashkvara, V.K. Maksimov, A.F. Bylinkin, L.S. Yurchak, A.A. Bok; UDC 10; 12]

[Abstract] A prototype of the new spherical energy spectrum analyzer of charged particle beams whose parameters—the radii ratio of the spherical electrodes and the deflecting potential—meet the condition of perfect angular focusing is developed and built on the basis of an electrostatic spherical capacitor. A schematic diagram of the spherical mirror analyzer (SZA) is cited and its design features are elaborated. Charged particles within a narrow spectrum band enter the analyzer through a round hole at the vertex of the inner electrode and are applied on the input of a channeling multiplier where they are detected. A broad axisymmetric secondary electron beam enters the spherical mirror analyzer field, is reflected, is focused on the outlet, and passes to the channeling multiplier. Secondary electrons are excited on the metallic surface sample by a 1 keV electron beam with a 0.2 mm diameter; the secondary electron beam divergence on the analyzer input is 20° in the meridional plane and 320° in the azimuthal direction; the receiving hole diameter is 0.2 mm. A 0.5 percent energy resolution is attained. The spherical mirror analyzer is uniquely characterized in that the longitudinal energy dispersion does not depend on the particle inlet angle and is equal to two inner sphere radii while the source is projected with central symmetry upon the opposite surface of the inner sphere, making the device promising for use in electron spectroscopy. Figures 1; references 2: 1 Russian, 1 Western.

Sharp Increase in Electron Beam-Pumped Xe Laser Efficiency

927J0107E Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 21, Nov 91 pp 76-79

[Article by B.M. Berkeliyev, V.A. Dolgikh, I.G. Rudoy, A.M. Soroka; UDC 02; 07]

[Abstract] The effect of various factors on the stimulated emission efficiency of high-pressure Ar/Xe lasers is discussed and an attempt is made to show that given a sufficiently high pumping power of 6 kW/cm^3 at close to 1 atm argon pressures, the stimulated emission efficiency (KPD) increases substantially when helium is added to the active medium composition. The dependence of the stimulated emission energy and efficiency on the helium pressure in Ar:Xe=100:1 mixtures is plotted. An increase in the stimulated emission efficiency by xenon's $5d$-$6p$ transitions is discovered only when the helium-containing mixtures are pumped by an electron beam with a density of over 40 A/cm^2; this is attributed to an increase in the speed at which the upper laser level is populated during the dissociative recombination with the participation of electrons which are "colder" in the presence of helium. It is noted that the effect of helium on the lasing efficiency decreases with a decrease in the pump power and becomes negligible in the case of low-power excitation. Figures 1; references 13: 11 Russian, 2 Western.

New Superconformal String

927J0110A Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 54 No 8, Oct 91 pp 417-420

[Article by V.A. Kudryavstev, Leningrad Nuclear Physics Institute imeni B.P. Konstantinov]

[Abstract] A new class of string models in which one can establish the correspondence of the string spectrum to the hadron spectrum while maintaining the superconformal symmetry of the spring amplitudes is examined. Two-dimensional fermion fields and two operators with an adjoint momentum are used to plot partial N-particle tree amplitudes for a new superconformal string model in the operator formalism whereby the new superconformal dynamics, in contrast to classical dual string models based on the dynamics of two-dimensional boson and fermion fields, are determined only by the two-dimensional fermion fields. The application of the Pauli principle to these fermion modes considerably narrows the physical states spectrum compared to the physical spectrum in classical string theories and makes it possible to compare it to the hadron spectrum of the interaction of π-mesons. In the physical states spectrum under study, there are no particles with a sufficiently high spin on the principal trajectory and any daughter trajectory; this trajectory extinction occurs for increasingly high spins with an increase in the daughter trajectory number. The maximum spin increases asymptotically in proportion to the mass of states; subsequent analysis of the new model's physical spectrum will be published soon. The authors are grateful to L.N. Lipatov, A.P. Bukhvostov, G.V. Frolov, Ye.N. Antonov, and other members of the LIYaF seminar for useful discussions of the results. References 5: 1 Russian, 4 Western.

Analysis of Sparse Signals at Baksan Underground Scintillation Telescope

927J0110B Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 54 No 8, Oct 91 pp 429-432

[Article by Ye.N. Alekseyev, L.N. Alekseyeva, V.N. Zakidyshev, A.Yu. Reutov, A.Ye. Chudakov, Nuclear Research Institute at the USSR Academy of Sciences, Moscow]

[Abstract] The recording of solar neutrino by the Baksan subterranean scintillation telescope of the Nuclear Research Institute at the USSR Academy of Sciences located at an 850 m.v.e. depth under the Andyrchi

mountain—an enclosed parallelepiped with two inner layers each of whose eight planes (four vertical and four horizontal) is solidly covered with standard 70 x 70 x 30 cm counters filled with a liquid organic scintillator and is viewed by a photomultiplier with a 15 cm photocathode diameter—is described. There is a total of 3,150 detectors with 330 tons of scintillator; the recording energy threshold is 10 MeV. Data received under a program of searching for neutrino flares from gravitational collapses of massive Galactic stellar nuclei and supernovas since 1980 are summarized. The trajectories composed of individual detector readings during a $\Delta t \leq 1$ s time are analyzed and a signal excess with a random simulation probability of 2×10^{-8} or 7σ in the direction toward the sun is discovered. The difficulties of interpreting this phenomenon are discussed. It is noted that it cannot be attributed to the interaction of muons traversing the telescope. Figures 3; references: 4 Western.

On Possibility of 'Cold Nuclear Fusion' in Deuterated $YBa_2Cu_3O_{7-x}$ Ceramics in Superconducting State

927J0113A Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 321 No 5, Aug 91 pp 958-962

[Article by A.G. Lipson, D.M. Sakov, Yu.P. Toporov, V.V. Gromov, B.V. Deryagin, Physical Chemistry Institute at the USSR Academy of Sciences, Moscow; UDC 538.945]

[Abstract] Intensive and extensive theoretical and experimental efforts to examine cold nuclear fusion (KhYaS) in a number of deuterated solids are summarized and the possibility of generating neutrons by deuterated samples of the $YBa_2Cu_3O_{7-x}$ ceramics both in normal and superconducting state is examined. It is noted that high-T_c superconductors (VTSP) in which the superconductivity mechanism is regarded to be of an exciton or bipolaron nature are the most suitable for this purpose. A schematic diagram of the device for studying the neutron emission during the cooling of very dense samples of high-T_c superconductor ceramics compacted at a 10 kbar pressure is cited. A 99.9 percent pure D_2O or an 1 M NaOD solution in D_2O is used as a deuterium source. The neutron emission parameters are summarized. The experiments show that for superconducting ceramic samples, the natural neutron emission background is exceeded only during an exposure to $T < T_c$ and is close to five standard deviations; in approximately 3 percent of the cases, there are three-, four-, and even five-neutron pulses extending 2-5 μs from each other. The experiments indicate that deuterated high-T_c ceramics in a stressed state may generate weak neutron fluxes commensurate in magnitude with neutron fluxes observed in deuterated metals during cold nuclear fusion. These data attest to a correlation between the cold nuclear fusion processes and superconductivity which may probably be manifested in other deuterated systems, including metallic. The need for further research to confirm these findings is emphasized. Figures 1; tables 1; references 15: 11 Russian, 4 Western.

On High-Energy Charged Particle Beam Rotation During Scattering by Chains of Bent Crystal Atoms

927J0135A Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 54 No 9, Nov 91 pp 520-524

[Article by A.A. Grinenko, N.F. Shulga, Kharkov Engineering Physics Institute]

[Abstract] The phenomenon of beam rotation in a bent crystal by an angle considerably greater that the critical angle of planar channeling is discussed and an attempt is made to demonstrate that a significant high-energy charged particle beam rotation is possible not only in the case of its movement along the crystallographic planes but also when the particles are traveling in a bent crystal along one of the crystallographic axes. This phenomenon is characterized in that the beam is rotated not due to the finite motion in the field of an atomic chain but due to the characteristics of multiple scattering of the overbarrier particles on atomic chains of the bent crystal. The advantage of this effect is that beam rotation is possible both for positively and negatively charged particles. Available experimental data are consistent with the theoretical findings which indicate that when particles are being scattered by atomic chains in a bent crystal, the beam may be effectively rotated by an angle of 10^{-4} rad; it is shown that to verify this conclusion, existing colliders with an energy of up to 100 GeV can be used. Figures 2; references 6: 3 Russian, 3 Western.

Mechanism of Intense Electron Beam Formation and Generation in Open Discharge

927J0143D Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 6, Jun 91 pp 61-68

[Article by P.A. Bokhan, Thermal Physics Institute at the Siberian Department of the USSR Academy of Sciences, Novosibirsk; UDC 04; 09]

[Abstract] The potential distribution in the accelerating gap (UZ) is measured and a physical model of the open discharge and runaway electron (UE) generation in it is developed on its basis. An attempt substantially to expand the functional capabilities of open discharge (OR) for generating intense electron beams (EP) is reported. The study established with a high degree of reliability that under optimal conditions for the electron beam generation in an open discharge, the field in the accelerating gap must be concentrated over a length commensurate with the wavelength. This increases the low-kinetic electron beam generation efficiency and makes it possible to produce accelerated atoms with an energy of up to several keV. The discharge glow and accelerated particle generation occur when the avalanche electron multiplication processes in the gas discharge gap are suppressed while the beam electrons appear on the cathode primarily under the effect of light biasing from an area located outside the discharge zone. It is noted that a certain degree of gas ionization in the accelerating

gap is necessary for developing a strong cathode potential drop (KPP) and increasing the beam generation efficiency as well as the efficiency of photobiasing from the drift space. Figures 3; tables 1; references 33: 22 Russian, 11 Western.

Cracks With Fractal Surface

927J0149A Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 319 No 4, Aug 91 pp 840-844

[Article by R.V. Goldshteyn, A.B. Mosolov, Mechanics Problems Institute at the USSR Academy of Sciences, Moscow; UDC 539.375]

[Abstract] Characteristics features of the crack surface structure, in particular its fractal properties on a certain intermediate scale of length or the so-called mesoscale are examined; in so doing, attention is focused on the consequences of the cracks' fractal nature allowing for the fact that the structural and geometrical characteristics of the crack surface and its fractal dimension may depend significantly on the fracture mechanism. For simplicity's sake, the case of brittle failure and crack propagation in a two-dimensional geometry, i.e., the planar problem, is considered and the results are analyzed from the viewpoint of the stochastic character of crack propagation in a solid; consequently, the values produced by averaging numerous crack trajectory realization are studied. It is assumed that a crack—a stochastic fractal of a >1 dimension—propagates in a solid under the effect of force; such averaged characteristics as stress and displacement field asymptotics at the crack apex and the functional dependence of the notch sensitivity index on the crack's geometric dimensions are analyzed. A fractal crack with a von Koch curve geometry is considered for illustration; it is shown that in the cased of nonbrittle fracture, energy is dissipated during the transition from one structural level to another. The results are extended to cracks in three-dimensional bodies. An analysis of the findings makes it possible to draw the conclusion that failure is a multifractal process and the fractured structure dimension is scale-dependent. Figures 1; references: 5 Western.

Three-Neutrino Oscillations in Matter and Topological Phases

927J0164A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 1, Jan 92 pp 3-17

[Article by V.A. Naumov, Scientific Research Institute of Applied Physics at the Irkutsk State University]

[Abstract] Neutrino oscillations in a medium with a variable density—a representative example of Schroedinger's evolution of dynamical systems with a time-dependent Hamiltonian characterized by the appearance of topological phases—are discussed and the evolution of a three-flavor system of Dirac's neutrino in a medium with arbitrary (i.e., smooth) density and composition distribution and arbitrary vacuum mixing parameters is investigated. The properties of the Hamiltonian spectrum and eigenvectors and the necessary and sufficient conditions of the appearance of Abelian topological phases and their correlation with the *CP*-symmetry disturbance are examined in detail and a precise matrix of the neutrino mixing in the medium is plotted. The adiabatic evolution operator and a recursive procedure for calculating corrections for the adiabatic approximation are formulated; it is demonstrated that Berry's phases appearing under periodically varying medium parameters vanish identically. It is speculated that *CP*-symmetry disturbance phenomena can be measured experimentally with the help of the next generation of underground detectors using accelerator neutrino beams and atmospheric neutrino. The author is grateful to A.N. Vall and V.M. Leviant for useful discussions. References 31: 5 Russian, 26 Western.

New Type of Weak Electron Localization in Nonordered Media

927J0177B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 2, Feb 92 pp 614-628

[Article by B.N. Libenson, K.Yu. Platonov, V.V. Rumyantsev, Leningrad State Engineering University]

[Abstract] Studies of the weak wave localization phenomenon manifested in coherent amplification of elastically scattered waves in nonordered media in an almost precise backward direction are surveyed and the importance of taking into account inelastic processes is noted. An attempt is made to demonstrate that in addition to the regular weak localization described by many authors, a new type of weak electron localization exists and is largely related to the inelastic phenomena whereby the origin of inelasticity is not significant. In so doing, three inelastic scattering mechanisms—excitation of plasmons and transverse electromagnetic waves by the electron in the medium and excitation and ionization of individual atoms—are considered and it is assumed that the inelastic phenomena decrease the probability of coherent processes. It is shown that a new coherent phenomenon exists in the noncrystalline substance under inelastic large-angle scattering of intermediate-energy electrons due to an interference of electron wave fields each of which as related to a possible realization of the multiple elastic electron scattering and scattering with a state excitation. The new localization type is universal in the sense of occurring regardless of the mechanism of the electron energy loss realization; the position of the localization function maximum depends little on the type of the inelastic process. Weak localization in the inelastic scattering channel can be expected in the case of oblique incidence upon a nonordered medium. The authors are grateful to O.A. Batalina for help with computer analyses. Figures 9; references 44: 15 Russian, 29 Western.

Optical Analogue of Magnus's Effect

927J0102A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 100 No 5(11), Nov 91 pp 1474-1482

[Article by A.V. Dugin, B.Ya. Zeldovich, N.D. Kundikova, V.S. Liberman, Chelyabinsk State Engineering University]

[Abstract] The Magnus effect whereby a spinning sphere free-falling in the air deflects from the vertical line in the direction of its spin is considered and an inverse (in a certain sense) phenomenon whereby the speckle-pattern rotates in a multimode optical fiber when circular polarization is switched from counterclockwise to clockwise is investigated. In the language of quantum mechanics, this phenomenon is considered as an outcome of the interaction of the orbital photon moment with its spin, i.e., polarization. This optical analogue of the Magnus effect is theoretically predicted and experimentally confirmed. The consistency of the theoretical results and experimental data is striking, (+1.5 +/- 0.5° vs. +1.4 +/- 0.5°, respectively) making it possible to state with certainty that the optical analog of the Magnus effect has been correctly predicted. Even the analytical findings for an optical fiber with a parabolic refractive index profile gives a rather good estimate (+3.3°) of the magnitude of the observed phenomenon. The authors are grateful to V.V. Shkunov for useful discussions and Z.A. Baskakov for providing the fiber. Figures 8; references 7: 5 Russian, 2 Western.

New Approach to Numerical Simulation of Scanning Tunnel Microscopy

927J0102C Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 100 No 5(11), Nov 91 pp 1640-1648

[Article by S.V. Meshkov, S.N. Molotkov, Solid State Physics Institute at the USSR Academy of Sciences]

[Abstract] The underlying principles of scanning tunnel microscopy and the shortcomings of existing approaches to measuring the tunnel current between the conducting crystal and the metallic tip are discussed and a principally new approach to analyzing the tunnel current is proposed. The central premise of the approach is that an electron sink at the tip's far end is formally added to the Hamiltonian of the system which consists of two crystal clusters—the specimen and the tip; the tunnel current is then calculated by analyzing the complex eigenvalue spectrum of the Hamiltonian whose diagonalization can be easily performed by standard numerical methods. The approach is versatile and reduces the task of calculating the tunnel current to the level of simplicity characterizing the analysis of the system's electron spectrum; in addition, it makes it possible strictly to take into account the atomic structure of the specimen and the tip and the reciprocal effect of the tip on the spectrum of crystal states on the surface. The method is illustrated in the framework of the tight binding concept Figures 5; references: 9 Western.

Experimental Confirmation of Possibility of Phase Object Superresolution

927J0134B Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 22, Nov 91 pp 80-84

[Article by V.P. Tychinskiy, A.V. Tavrov, D.O. Shchepelskiy, A.G. Shchuchkin; UDC 07; 12]

[Abstract] The use of computer processing methods and the unusual properties of phase-contrast images laid the groundwork for developing a computer-aided phase-contrast microscope with a superRayleigh resolution; an attempt to establish the extent to which the phase distribution is adequate to the object and determine whether the distribution may be considered as a characteristic of the object profile is reported. Measurement are taken using an Airyscan phase-contrast computer-aided microscope developed on the basis of a Linnik interferometer; a He-Ne laser emitting on a 0.63 μm wavelength is used as a light source, and a dissector is used for recording the interference signal. The phase distribution image is displayed on an IBM PC/AT computer as a stereo projection with the help of a special electronic unit and software. The cross section of a semiconductor structure with a 0.1 μm gap in the SiO_2 layer obtained under a Hitachi S-800 scanning electron microscope in the video signal mode is cited and a stereo image of an aquatic plant is shown. The conclusion is drawn that the images obtained in the experiment confirm the possibility of using the Airyscan computer-aided phase-contrast microscope (KFM) for microorganism, integrated circuit, magnetic bubble, and other types of microscopy with a high (superRayleigh) resolution. Figures 3; references 9: 4 Russian, 5 Western.

Study of Quantum Wells by *C-V* Method

927J0140A Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 25 No 6, Jun 91 pp 1047-1052

[Article by V.Ya. Aleshkin, Ye.V. Demidov, B.N. Zvonkov, A.V. Murel, Yu.A. Romanov, Scientific Research Institute of Engineering Physics at the State University imeni N.I. Lobachevskiy, Nizhniy Novgorod]

[Abstract] Advances in the technology of heterostructures with quantum wells as (KYa) and the advantages of the *C-V* method for studying quantum phenomena are discussed and an attempt to demonstrate that the *C-V* characteristics of heterostructures with quantum wells can serve as the source of information about the distance from the quantum well to the semiconductor surface, the surface concentration of the principal carriers and dopant in the quantum well, and the depth of the two-dimensional subband is described. A uniformly

doped semiconductor with the center of the quantum well at a known distance from its surface is considered and it is assumed that the electron wave function dimensions in the quantum well are much smaller than the characteristic length of the space charge areas (OPZ) and that the frequency at which capacitance is measured is much smaller than the reciprocal equilibration time in the system. Two cases are considered: the dopant atoms are ionized at all temperatures which is characteristic of *n*-GaAs, and carriers are frozen at $T \to 0$, such as *p*-GaAs. The tails of the density of states in the two-dimensional subband are estimated. The authors are grateful to A.V. Bespalov and I.G. Malkina for help with the experiment. Figures 3; references 9: 4 Russian, 5 Western.

Photoresponse Saturation During Holographic Recording in Bacteriorhodopsin

927J0151A Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 7, Jul 91 pp 116-120

[Article by Yu.O. Barmenkov, N.K. Kozhevnikov, Leningrad State Engineering University; UDC 07]

[Abstract] The use of photorefractive media containing bacteriorhodopsin (FSBR) in dynamic holographic interferometry and the nonlinear local response of photorefractive media containing bacteriorhodopsin due to the difference in the bacteriorhodopsin (BR) molecules' dipole moments in the *trans* ground state or the photoexcited *cis* state is discussed and it is demonstrated theoretically and experimentally that the character of the photoresponse saturation manifestations in the course of holographic processes in various photorefractive media containing bacteriorhodopsin is determined by the molecule excitation relaxation mechanisms—linear or square-law—and under certain conditions, makes it possible to attain a high value of diffraction efficiency at the initial stage of dynamic hologram formation. It is shown that the dependence of the phase grating on the light beam intensity is also determined by the interference pattern contrast. Preliminary dark adaptation and simultaneous switching of high-power recording beams greatly increase the phase grating amplitude at the initial stage. It is noted that the above general analysis may be used in examining the holographic processes in other media with a weak Kerr nonlinearity. As for photorefractive media containing bacteriorhodopsin, the analytical results confirmed experimentally make it possible to optimize the recording of dynamic holograms in order to increase their diffraction efficiency. Figures 4; references 8.

Running Hologram Recording in Suspensions Containing Bacteriorhodopsin

927J0151B Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 7, Jul 91 pp 121-125

[Article by Yu.O. Barmenkov, N.M. Kozhevnikov, Leningrad State Engineering University; UDC 07; 03]

[Abstract] Nondegenerate two-beam interaction (NDV) in photorefractive crystals leading to the formation of running phase holograms widely used for enhancing the beam energy transfer is described and a procedure of using the nondegenerate two-beam interaction for examining weakly nonlinear media with a local Kerr photoresponse is investigated using aqueous suspensions containing bacteriorhodopsin (VSBR). To this end, the transformation of harmonic phase modulation to intensity modulation of nondegenerate light beams which record a dynamic hologram in an aqueous suspension containing bacteriorhodopsin is experimentally examined; the results confirm the development of amplitude and phase gratings in the medium which are equivalent to spatial modulation of the medium's absorptance and dielectric permittivity. The gratings' steady-state amplitudes depend on the light beams' frequency difference and photoresponse time constants. Spectral amplitude kinetics of the output beam intensity fluctuations oscillate as a function of the grating mismatch. The study confirms the existence of amplitude-phase gratings in aqueous suspensions containing bacteriorhodopsin and makes it possible to estimate each grating's contribution to the energy transfer between the phase-modulated beams. The results may be used for developing specific designs of adaptive holographic interferometers. Figures 4; references 9: 7 Russian, 2 Western.

Soliton Model of Data Recording on Molecular Films

927J0151E Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 7, Jul 91 pp 76-83

[Article by Yu.B. Gaydidey, A.S. Trofimov, Theoretical Physics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 05; 12]

[Abstract] Two-dimensional orientationally ordered molecular structures are investigated in order to ascertain the possibility of using them for recording and storing data and establish the conditions under which several nonequilibrium yet sufficiently stable states develop in these systems. The physical phenomena which determine this system's transition from one state to another, i.e., the data writing process, are examined. Langmuir films of azo dye molecules are used in the study. The effect of polarized light on the structure of such orientationally ordered films is analyzed and it is shown that under certain conditions, orientational reordering of molecules occurs in this film under exposure to light. The nonequilibrium potential function of the orientational degrees of freedom in the absence of dispersion is plotted and the periodic domain structure of the molecular layer under the effect of light and the structure of the nonirradiated film are examined. The domain wall distortion under the effect of light is studied and it is noted that the molecules are reoriented primarily due to the cooperative effects developing in the domains during the excitation of molecules; this also explains the substantial molecular reordering in the layer even under

weak activating irradiation and the long-term preservation of the domain wall shape after the end of irradiation. Figures 3; references 6: 3 Russian, 3 Western.

Combined Method of Analyzing Channel Waveguide Characteristics

927J0161A Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 8, Aug 91 pp 8-14

[Article by Ye.A. Bozhevolnaya, S.I. Bozhevolnyy, Microelectronics Institute at the USSR Academy of Sciences, Scientific Center for Fundamental Problems of Automatic Data Processing, Yaroslavl; UDC 01; 09]

[Abstract] The need to analyze the characteristics of channel waveguides at various waveguide structure parameters in order to optimize integrated optics devices is stressed and a combined method based on an iterative procedure of computing the correction for the propagation constant and stepwise approximation of the refractive index is proposed for determining the characteristics of channel waveguides in the approximation of the effective refractive index profile method. The method is explicated for the case of a random waveguide refractive index profile using normalized parameters, thus significantly expanding the applications of the resulting data. The method's accuracy is estimated by comparing it to known results produced by the finite elements method for both planar and channel waveguides. The method is rather versatile and fast, making it possible to solve various types of optimization problems requiring multiple computations of the waveguide's mode characteristics. The CPU time for calculating the effective refractive index and mode field distribution using the Fortran-77 routine does not exceed 1 min on an IBM PC/AT microcomputer or 3 s on a VAX 8700 mainframe. The proposed method is illustrated by finding the characteristics of Ti:$LiNbO_3$ channel waveguides within a broad normalized parameter range. Figures 4; tables 1; references 18: 1 Russian, 17 Western.

Are Known Fundamental Principles of Holography Sufficient for Developing New Types of 3-D Cinema and Artificial Intelligence?

927J0161C Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 8, Aug 91 pp 149-161

[Article by Yu.I. Denisyuk, Engineering Physics Institute imeni A.F. Ioffe at the USSR Academy of Sciences, Leningrad; UDC 07]

[Abstract] The origins of today's holography from D. Gabor's discovery in 1949 to the present and the underlying principles of creating the mental perception of a three-dimensional image by reconstructing the optical waves received by the eye and processed by the brain are outlined and the properties of two- and three-dimensional, polarization, dynamic, and echo holograms are considered; the inversibility of three-dimensional holograms is discussed and it is shown that the mathematical transition to the conjugated wave being reconstructed by 3-D holograms corresponds to the complex conjugation operation. Methods of reconstructing virtually the entire set of wave field parameters such as phase, amplitude, spectral composition, and polarization and their behavior from various types of holograms are considered. The effect of oriented energy transfer between the interfering waves in a lithium niobate crystal relevant to 3-D holographic recording is described. Attempts to develop holographic cinema in the USSR undertaken by Prof. V.G. Komar in 1976-1984 are described and a diagram of the device developed as a result of these efforts is cited. Data recording on a pseudodeep sloping hologram is considered and the outlook for holography applications in optical computers and for developing a holographic associative memory is discussed; the features if intersegment links executed with the help of 2-D, 3-D, waveguide, and pseudodeep holograms are examined. Figures 10; references 28: 11 Russian, 17 Western.

Nonresonant Nonlinear Polarization Response of Matter in Extremely Short Light Pulse Field

927J0163A Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 71 No 2, Feb 91 pp 334-339

[Article by A.N. Azarenkov, G.B. Altshuller, S.A. Kozlov, Leningrad Precision Mechanics and Optics Institute; UDC 535.2]

[Abstract] Light pulses containing just a few field oscillations—the so-called extremely short pulses (PKI)—and the characteristic features of their interaction with matter are discussed; in particular, the character of nonlinear polarization response of a transmitting medium, such a wide-band dielectrics and atomic-molecular systems in the transmission band, responsible for nonlinear refraction and the related light self-action phenomena are investigated; attention is focused on correctly describing the nonlinear response lag. The constitutive relations describing the polarization response as a cubic function of the field are derived on the basis of the density matrix formalism in the three-level medium model approximation whereby two transitions are forbidden and one is permitted. Neumann's equations for the density matrix element movement are derived. It is shown that the nonlinear polarization lag is determined by two effective relaxation times. It is noted that in order to describe the extremely short pulse propagation in a cubically nonlinear medium correctly, the constitutive relations must be solved jointly with the wave equation. The systems of equations and relations describe both the nonlinear medium dispersion and all the nonlinear phenomena related to the cubic-field polarization: a change in the phase velocity, stimulated Raman scattering, two-photon absorption, etc., which cannot always be separated in the case of extremely short pulses. Figures 1; references 13: 7 Russian, 6 Western.

Investigation of Fractons in Polymers

927J0164D Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 1, Jan 92 pp 284-293

[Article by M.G. Zemlyanov, V.K. Malinovskiy, V.N. Novikov, P.P. Parshin, A.P. Sokolov, Automation and Electrometry Institute at the Siberian Department of Russia's Academy of Sciences]

[Abstract] Vibratory properties of nonordered fractal systems and the issue of fracton localization on fractals are addressed and efforts of various researchers in this field are reviewed. Fractons are investigated in detail in one typical manifestation of fractal systems—polymers, and particularly in polymethylmethacrylate (PMMA). The authors' earlier finding that PMMA exhibits fractal behavior on a scale of $L \leqq 30$-50 angstrom is confirmed. Samples of regular and deuterated PMMA are examined by two methods—low-energy inelastic scattering and low-frequency Raman light scattering (KRS)—and a comparative analysis of the results is performed. The vibratory states density found with the help of neutron scattering in a 2.5-10 meV energy range depends exponentially on energy; this corresponds to the fracton vibration mode with a spectral dimension of $\tilde{d}$=1.8 +/- 0.05. The model of light scattering by fractons and the spectral dimension found in the neutron experiment make it possible to calculate the superlocalization fracton index which is equal to $d_\Phi \approx 1.5$. Close values of $\tilde{d}$ and d_Φ are also discovered in deuterated PMMA samples. The authors are grateful to V.A. Bagryanskiy for providing PMMA samples and discussing the findings. Figures 3; tables 1; references 29: 4 Russian, 25 Western.

Self-Diffraction and Conjugation in Atomic Gas With Hyperfine Level Structure

927J0177A Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 101 No 2, Feb 92 pp 435-459

[Article by A.I. Alekseyev, Moscow Engineering Physics Institute]

[Abstract] The inadequacy of the results produced in the framework of a model of gas atoms with a zero nucleus spin or a two-level atom model with a nonzero nucleus spin for describing the patterns of self-diffraction and conjugation (OVF) inside the line of single-quantum atomic absorption which are solely due to the hyperfine resonant level structure prompted a study of self-diffusion and front conjugation of stationary light waves with an arbitrary polarization in a gas of atoms with a hyperfine level structure. The study is carried out on general assumptions which simultaneously take into account the resonant level degeneracy, thermal motion, the transfer of atoms to a lower level due to the radiative decay of the excited state, and linear absorption and a change in the light waves' refractive index when buffer gas is added. The intensity of the light waves used in the study is sufficiently low, enabling us to ignore the saturation effect and use the perturbation theory which is applicable to both degenerate and nondegenerate four-wave light mixing in the case where all four light waves are resonant with the same single-quantum atomic transition, i.e., coupled waves. The tensor of cubic susceptibility is derived and the polarization and amplitude patterns of nonlinear phenomena are established. References 46: 24 Russian, 22 Western.

Stochastic Model of High-Pressure Microwave Discharge

927J0102B Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 100 No 5(11), Nov 91 pp 1502-1510

[Article by O.A. Sinkevich, V.Ye. Sosnin, Moscow Energy Institute]

[Abstract] The limitations and shortcomings of existing models of the steady-state non-self-sustained microwave (SVCh) space discharge, particularly the electromagnetic field stochastization in the discharge area, are discussed and the simplest stochastic model of the high-pressure microwave discharge is investigated. It is shown that correct description of the microwave field interaction with the discharge plasma inhomogeneities is possible only in the framework of jointly solving the plasma equations and the field equations. A method of analyzing the distribution of high-pressure microwave discharge plasma parameters is proposed on the assumption of electromagnetic field stochastization in the discharge area; a differential equations which describes the evolution of the plasma parameter distribution function in the framework of the electromagnetic field model with a fully stochastized phase and direction is derived. It is noted that the above analysis does not provide data on the structure of the resulting plasma formations and, consequently, additional considerations must be employed in order to estimate the characteristic dimensions of the plasma inhomogeneities. Mr. Sinkevich is grateful to I.A. Kosoy who brought this type of discharge to his attention and both authors are grateful to A.A. Rukhadze and the participants in his seminar for discussing the findings. Figures 2; references 13.

Nonlinear Dynamics of Dissipative Filamentary Electron Current Instability in Magnetoactive Plasma

927J0160B Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 20, Oct 91 pp 13-17

[Article by V.P. Pasko, Kiev State University imeni T.G. Shevchenko; UDC 01; 04; 10]

[Abstract] Various stages of filamentary instability of the electron current in plasma are discussed and the nonlinear dynamics of filamentary instability of an electron current drifting in plasma under the effect of an external magnetic field and collisions with in the plasma and the current is analyzed; in so doing, attention is focused on the case of a weak flux in a strong magnetic field where the instability increment is determined by the collisions of flux electrons with the plasma-neutral background. Filamentary instability is numerically simulated by the nonradiative method. Phase portraits of the flux instability development and the dependence of the transverse kinetic energy of the flux, transverse kinetic energy of plasma, and magnetic field energy normalized for the initial kinetic energy of the system on time are plotted. The results of numerical simulation are consistent with published data. It is demonstrated that the instability is completely suppressed in a strong magnetic field which is consistent with the linear theory. It is also shown that despite a slower time progress of instability compared to the nonmagnetized collisionless case, a similar trend toward gradual merger of filaments during heating is observed; this process slows down considerably as the filaments become larger. Figures 2; references 11: 7 Russian, 4 Western.

On Anisotropy of Magnetic Properties in Exotic Superconductors

927J0102D Moscow ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 100 No 5(11), Nov 91 pp 1699-1710

[Article by Yu.S. Barash, A.V. Galaktionov, Physics Institute imeni N.P. Lebedev at the USSR Academy of Sciences]

[Abstract] Superconductors with nontrivial pairing—the so-called exotic superconductors, e.g., the hexagonal UPt_3 superconductor with heavy fermions, and the importance of knowing the anisotropy of their magnetic properties—are discussed and approximate equations which describe with sufficient accuracy the anisotropy of the upper critical field in hexagonal and rhombohedral exotic superconductors where the field lies in the plane passing through the sixth or fourth order axis, respectively, are derived. It is shown that the rosette-type anisotropy occurs only in the case of rhombohedral crystal symmetry. Moreover, the problem of the special anisotropy of fluctuation diamagnetism in a rhombohedral superconductor with nontrivial pairing is solved and it is shown that the field-nonlinear part of the induced magnetic moment in the normal phase near T_c displays special asymmetry in two Cartesian coordinate planes relative to the magnetic field reflections of the same type as the upper critical field. Figures 3; references 30: 10 Russian, 20 Western.

Search for Time Inversion Symmetry Violation in High-T_c Superconductors

927J0110D Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 54 No 8, Oct 91 pp 453-459

[Article by A.G. Aronov, V.F. Masterov, St. Petersburg State Engineering University]

[Abstract] The concept of the existence of particles with fractional statistics—the anyons—which may explain the high-T_c superconductivity (VTSP) phenomenon is discussed and the search for a state with a violated T-invariance with the help of another method which was not considered by Halperin, March-Russell *et al.* (HUTP-89/A010 Preprint) is reported; studies of the even magnetic field harmonics generation in high-T_c superconductor single crystals are reviewed. A method of determining the anyon-induced internal magnetic field in high-T_c superconductors is suggested on the basis of measuring the even magnetic field harmonics generated by a nonlinear medium, e.g., Bi2212 single crystals with nuclei of the 2223 phase. The dependence of the fourth harmonic amplitude on the transverse field strength for a set of single crystal samples and the dependence of the fourth harmonic amplitude on the static longitudinal magnetic field strength for a set of single crystal samples are plotted. The experiments demonstrate that even if an internal anyon field does exist in high-T_c superconductors at a T=77K temperature, it is lower than 10^{-3} G. The authors are grateful to N.M. Shibanova and V.V. Potapov for providing the single crystals and V.K. Sobolevskiy and Z.T. Maksutova for help with the experiment. Figures 2; references 8: 2 Russian, 6 Western.

Structural Instability of $Bi_{2.2}Sr_{1.8}CaCu_2O_{8+x}$ Single Crystals at Low Temperatures

927J0114A Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 35 No 11, Nov 91 pp 991-993

[Article by N.D. Zhigadlo, Solid State and Semiconductor Physics Institute at Belarus Academy of Sciences; submitted by Academician of Belarus Academy of Sciences B.B. Boyko; UDC 539.26:538.945]

[Abstract] The existence of at least three superconducting phases in the Bi-Sr-Ca-Cu-O system with a general formula of $Bi_2Sr_2Ca_{n-1}Cu_nO_x$, where n=1, 2, 3, with a T_c of 7-22K, 85K, and 110K, respectively, is discussed and $Bi_{2.2}Sr_{1.8}CaCu_2O_{8+x}$ single crystals crystallized from a melt of finely dispersed oxide and carbonate powders are investigated. X-ray structural analyses are conducted in a DRON-4-07 diffractometer using Cu*K* radiation. A model of the single crystal structure is constructed and the temperature dependence of the crystal lattice constant c is plotted. The results of the X-ray structural analysis reveal only the presence of the 2212 phase in the [00*l*] direction; an analysis of the temperature behavior of the lattice constant points toward the existence of two temperature ranges, 75-110K and 220-245K, where the $c(T)$ function is nonmonotonic. The findings correlate rather well with the results of ultrasonic studies and make it possible to draw the conclusion that the $Bi_{2.2}Sr_{1.8}CaCu_2O_{8+x}$ crystal lattice becomes unstable within these temperature ranges; it is noted that the nature of this structural instability cannot yet be established conclusively; the need for further studies in order to determine the role of the modulation wave vector **q** is emphasized. Figures 2; references 15: 3 Russian, 12 Western.

On Transformation of Acoustic Waves on Superconductor Layer in Piezoelectric Crystals

927J0132A Moscow KRISTALLOGRAFIYA in Russian Vol 36 No 5, Sep-Oct 91 pp 1063-1067

[Article by V.I. Alshits, V.N. Lyubimov, Crystallography Institute at the USSR Academy of Sciences and Physicochemical Scientific Research Institute imeni L.Ya. Karpov; UDC 537.312.62]

[Abstract] The transformation of an acoustic wave being reflected by a thin superconductor layer located on the surface of a cubic or tetragonal piezoelectric crystal or embedded into it is examined in the case where the anisotropy of the crystals' acoustic properties is significant. The issue of selecting the optimum piezoelectric crystal/superconductor interface surface orientation is

considered in order to identify the conditions under which such wave transformation during reflection is the greatest. The behavior of wave parameters during the layer transition from the superconducting state to normal is investigated and the cases of acoustic wave localization near the layer are identified. A theorem reflecting the correlation between the existence of Bluestein-Gulyayev and Rayleigh surface waves with varying polarization on the superconducting surface of a piezomagnetic crystal is formulated. It is demonstrated that if the surface is mechanically free and is bounded by an infinitely conducting medium, there exist at least one but no more than two surface waves. Figures 2; references 10: 8 Russian, 2 Western.

Thermooptical Sound Excitation in Nonlinear Piezoelectric Crystals

927J0132C Moscow KRISTALLOGRAFIYA in Russian Vol 36 No 5, Sep-Oct 91 pp 1250-1253

[Article by G.S. Mityurich, V.P. Zelenyy, Gomel State University; UDC 534.341.08]

[Abstract] The method of photoacoustic (FA) spectroscopy based on the phenomenon of laser-induced acoustic wave generation in a medium which is absorbing amplitude-modulated or pulsed electromagnetic radiation is discussed and photoacoustic transformation in gyrotropic piezoelectric crystals of various symmetry classes is investigated. It is shown that modulated absorption of normally incident radiation upon the absorbing gyrotropic crystal leads to thermooptical generation of elastic waves and (through linear, nonlinear, or combined piezoeffect) the development of a potential difference on the crystal faces. Photoacoustic interaction in nonlinear piezocrystals is considered and the crystals' properties are described with the help of nonlinear crystal acoustics relationships. The possibility of determining the quadratic piezoeffect tensor components in class 432 crystals as well as the circular dichroism parameter of cubic and uniaxial crystals by the piezoelectric photoacoustic spectroscopy methods—by measuring the amplitude characteristics of the photoacoustic signal—is demonstrated. It is noted that there are two base resonance frequencies in class 432 crystal due to the propagation of two elastic waves with different wavelengths. Figures 1; tables 1; references 4.

Observation of New Blue Phase

927J0132D Moscow KRISTALLOGRAFIYA in Russian Vol 36 No 5, Sep-Oct 91 pp 1325-1327

[Article by G.Sh. Petriashvili, G.S. Chilaya, Georgian Cybernetics Institute; UDC 548.0]

[Abstract] Three blue phases (FF) which exist in a narrow temperature range during the transition from the cholesteric phase to isotropic, two of which (GFI and GFII) are ordered and the third (the so-called "fog" GFIII phase) is nonordered, are discussed and the discovery of a new ordered blue phase—GFIA—which appears between the GFI and the cholesteric phase during cooling is reported. The phase diagram of three-components mixtures of two nematic substances with optically active nonmesogenic thigogenincaprylate (TK) are plotted as a function of the TK concentration and transmission spectra are examined during cooling and heating. The temperature dependence of the selective reflection maximum is plotted. An analysis of the spectra shows that the structure and orientation of the blue phase cells and their dependence on the thermal prehistory are largely the same as that of cholesterol ethers and chiral nematic substances. The authors are grateful to V.Ye. Dmitriyenko for valuable discussions. Figures 3; references 11: 4 Russian, 7 Western.

Specific Features of Temperature Behavior of 'High-T_c Semiconductor-Degenerate Semiconductor' Heterojunction Resistance in Neighborhood of T_c

927J0134A Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 22, Nov 91 pp 15-18

[Article by V.W. Bunda, Uzhgorod State University; UDC 05.4; 06.1]

[Abstract] The specific features of the electrophysical properties of high-T_c superconductor (VTSP)-semiconductor (PP) heterojunctions (GP) in the TT_c temperature area are discussed and an attempt to develop technology for producing reliable tunnel $YBa_2Cu_3O_{7-\delta}$-semiconductor heterojunctions is reported. To overcome known difficulties, BiOX tetragonal bismuth oxyhalide compounds (X=halide)—laminar wide-band photoconductors with a number of advantages—are used as semiconductor layers. The temperature dependence of yttrium-barium cuprate and ceramic YBaCuO-BiOCl:Ti heterojunction in the through and planar configuration is plotted. The energy band model of the heterojunction and the current transport mechanism in it are considered. An analysis of the findings indicates that in the vicinity of the 95-98K heterojunction temperature, the high-T_c superconductor reverts to the resistive state; the gap width approaches zero; an inverse injection of holes from the semiconductor layer to the YBaCuO layer with subsequent thermalization occur; and the holes are effectively captured by the semiconductor attraction centers. At T105K, the heterojunction behaves as a semiconductor, i.e., $R(T)$ is determined solely by the heterojunction's semiconductor layer proper. Figures 2; references 8: 4 Russian, 4 Western.

Precursor Formation During Optoacoustic Pulse Propagation in Near-Surface Ocean Layer

927J0134C Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 22, Nov 91 pp 95-99

[Article by V.D. Kiselev, A.O. Maksimov, Pacific Oceanographic Institute at the Far Eastern Department of the USSR Academy of Sciences; UDC 03; 07; 08]

[Abstract] Experiments aimed at generating optoacoustic pulses in sea water which revealed differences in the shape of the acoustic signals received from that of signals recorded in lab conditions are discussed and an attempt is made to explain the distortions observed on the leading edge of these pulses in a number of experiments where the pulse source is formed by a beam of a CO_2 laser with a characteristic radius of 1.5 cm whereby the sound is emitted from a near-surface layer of a micrometer thickness with an absorptance of 870 cm^{-1} and acoustic signals are recorded by a hydrophone located 8 m deep under the spot. The precursor formation as a function of the dispersion parameter and the acoustic pulse shape recorded at an 8 m depth are plotted. An analysis of experimental data confirms that, as stated earlier by various authors, the precursor indeed forms on the leading edge of the acoustooptic pulse propagating in the near-surface ocean layer and the distortions observed in the experiments are attributed to the precursor formation. Figures 2; references 11: 8 Russian, 3 Western.

Critical Behavior of Superconducting Composites' Josephson Frequency

927J0135C Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 54 No 9, Nov 91 pp 496-498

[Article by A.Ye. Morozovskiy, Physics of Metals Institute at the Ukrainian Academy of Sciences, Kiev]

[Abstract] The properties of high-T_c ceramics and composites are outlined, a new feature of the nonstationary Josephson effect in superconductor composites is investigated, and critical indices of the Josephson radiation frequency—the dependence of the Josephson radiation frequency on the superconducting phase concentration—are examined. To this end, superconducting composites consisting of elements with a minimum size whose superconducting phase concentration is higher than the current threshold are considered; it is assumed that in the normal state, the conductivity of phase 1, e.g., a metal which passes to the superconducting state with a drop in temperature, is much higher than that of phase 2, e.g., an insulator or a semiconductor. It is further assumed that near the current threshold, the Josephson frequency, and other quantities change critically; this assumption is confirmed in the study on the basis of the "weak link" model according to which at a well-conducting phase concentration greater than the current threshold, a highly inhomogeneous medium represents bases with a large cross section (phase 1) connected parallel to the narrow long bridges and thin bent layers (phase 2); at a higher-than-critical current, the bridges and layers pass to the normal state but bases remain superconducting; this is accompanied by Josephson generation. Thus, it is confirmed that the Josephson radiation frequency depends on the superconducting phase concentration. The author is grateful to A.M. Gabov and A.A. Snarskiy for discussing the findings. References 8: 6 Russian, 2 Western.

T_c of Multilayer Superconductors. Josephson's Frustrated *X-Y* Model

927J0138C Sankt-Peterburg FIZIKA TVERDOGO TELA in Russian Vol 33 No 9, Sep 91 pp 2760-2762

[Article by V.A. Cherenkov, "Stabilization" Provisional Scientific Technical Council, Moscow; UDC 539.2:539.292]

[Abstract] The issue of the maximum T_c in laminar perovskite-T_c superconductor (VTSP) structures is addressed and an attempt is made to determine the T_c of multilayer S-N(D)-S and S-N(J)-S superconducting structures on the basis of the resonant valence bond (RVB) theory allowing for the tunneling of resonant pairs between the superconducting layers. The Josephson lattice defects are taken into account by the frustration parameter. Tunneling of superconducting singlet pairs in the RVB theory is described by a Hamiltonian and equations are derived for calculating the critical temperature allowing for tunneling from the two nearest layers. It is shown that even in the case where an identical constant of interaction between the nearest layers is maintained for all layers, the introduction of layer frustration leads to a $T_c(n)$ hysteresis, i.e., a phenomenon of irreversibility which is typical of many new T_c superconductors. The author is grateful to Ye.A. Shapoval for interest in the effort. References 8: 2 Russian, 6 Western.

Infrared Radiation Detection Mechanism by High-T_c Bolometer

927J0160C Sankt-Peterburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 20, Oct 91 pp 28-33

[Article by V.N. Alfeyev, S.G. Orlov, A.N. Sukhanov; UDC 05.4; 07; 12]

[Abstract] The shortcomings of traditional superconducting bolometers consisting of a superconducting film (SPP), a base, and a thermostat due to a lowering of their detection threshold at high speeds are discussed and a new mechanism of the high-T_c bolometer operation which makes it possible substantially to increase its speed without degrading its detecting ability is investigated. A block diagram of the bolometer which is connected to the input of a differential amplifier with parallel voltage feedback and an additional voltage source ensuring a constant bias on the bolometer is cited and its operating principle is outlined. The parameters of the system ensure that the bolometer temperature changes due to absorption of the signal radiation are equalized by Joule power variations; likewise, the temperature relaxation time and the bolometer sluggishness are short. The proposed mechanism makes it possible to attain a detection threshold limit of 1.3 x 10^{10} cm $Hz^{1/2}/W$ at a speed of less than 1 ms and an operating temperature of over 90K. Figures 2; references 3.

Fractal Dimension of Cracks Formed by Brittle Failure of Model Lattices and Solids

927J0117B Leningrad PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 17 No 17, Sep 91 pp 63-67

[Article by A.S. Balankin, A.L. Bugrimov; UDC 01; 05.1]

[Abstract] The self-similar structure of cracks formed in solids which reflects the fractal dynamics of the failure process and the fractal dimension of self-similar crack configurations which does not depend on the type of load (tension, compression, or shear) simulated by the boundary value conditions but is determined by Poisson's ratio and the stress exponent m describing the dependence of the probability of the bond break between two adjacent lattice sites on the stress are discussed. The dependence of the fractal dimension on the exponent, $d_f(m)$ is examined and unilateral straining (with a constant longitudinal component and null transverse component) of a planar lattice under the effect of longitudinal stress is considered and the results are compared to the outcome of numerical simulation. Propagation of a fractal crack in the case where the bond break is determined by Griffiths's criterion and the fractal dimension of Griffiths's self-similar crack are analyzed and compared to the models of viscous failure, viscoelastic body failure, and classical Griffiths's cracks. The dependence of the notch sensitivity index on the lattice parameter R is derived and the failure mechanism is considered as a process of defect clustering described by Smolukhovskiy's equation. The authors are grateful to A.B. Mosolov for providing data and discussing the findings and to Ye.I. Shemyakin for attention and advice on the issues of fractal mechanics of deformable solids. Tables 1; references 11: 9 Russian, 2 Western.

RF Nuclear Gamma Resonance Spectra of Stochastic Bistable Magnetic Systems

927J0138B Sankt-Peterburg FIZIKA TVERDOGO TELA in Russian Vol 33 No 9, Sep 91 pp 2725-2732

[Article by E.K. Sadykov, A.I. Skvortsov, Kazan State University imeni V.I. Ulyanov (Lenin); UDC 538.245+548.66]

[Abstract] The behavior of a stochastic bistable system under the effect of a weak coherent signal and stochastic resonance (SR) is addressed and the changes in the output noise spectrum of such a system, e.g., the appearance of a coherent signal, under the effect of an RF field and the resulting shape distortions of Mossbauer spectra (MS) are investigated. To this end, the behavior of a ferromagnetic or ferrimagnetic superparamagnetic particle (SPCh) of the "axis of easy magnetization" type in the RF field which sustains its bistability mode is considered. Analyses demonstrate that satellites appear in the Mossbauer spectrum of such a system; this phenomenon is interpreted on the basis of the stochastic resonance concept. The consideration is made in the framework of the discrete orientations model (MDO). An analysis of the stochastic magnetization dynamics modulation of superparamagnetic particles can be made outside the discrete orientations model in exceptional cases. The effect of the particle volume spread on the model applicability is discussed and it is shown that this spread does not play a significant role in observing the above phenomena. Figures 4; references 20: 5 Russian, 15 Western.

Griffiths's Fractal Crack

927J0151D Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 61 No 7, Jul 91 pp 57-60

[Article by A.B. Mosolov, Institute of Mechanics Problems at the USSR Academy of Sciences, Moscow; UDC 01; 05]

[Abstract] The possibility of simulating the irregular crack surface structure by fractal surfaces is addressed and the factors and patterns of the fractal geometry development during the fracture of materials are discussed; the consequences of the crack surface's fractal characteristics are studied in the case of brittle failure. To this end, crack propagation is first examined in a two-dimensional geometry as a planar problem whereby the crack growth in a solid is largely stochastic; consequently, the characteristics obtained as a result of averaging over realizations are emphasized. Griffiths's criterion is used to establish the dependence of the notch sensitivity index on the load and the mean crack size and its fractal dimension. Asymptotic laws which characterize the stress behavior and divergence in the crack vertex area are established. It is shown that the results can be easily extended to the case of cracks in three-dimensional bodies and that different models of cracks with a fractal geometry may be considered in the three-dimensional case. The author is grateful to R.V. Goldshteyn and F.M. Borodich for stimulating discussions. Figures 1; references 10: 4 Russian, 6 Western.

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